

DEPARTMENT OF AGRICULTURE, BEHAR AND ORISSA.

CROP PEST HANDBOOK

FOR

BEHAR AND ORISSA

(INCLUDING ALSO WESTERN BENGAL).

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INTRODUCTION.

WITH the creation of an Imperial Agricultural Department and the appointment of an Imperial Mycologist and Entomologist the work of combating the crop pests of India was commenced in earnest. As a result of the work done at Pusa sufficient material was soon collected to justify the creation of Provincial establishments to bring into general use the remedies recommended. The Bengal Department of Agriculture took up the work in May 1910, with a staff consisting of an Entomological and Mycological Assistant who had been trained at Pusa since 1905, and two Professors who had received part of their training in England or America and had worked for some time at Pusa. With no larger staff than this the Department would have only frittered away its energies uselessly if it had attempted to give personal assistance in all cases of damage done by pests, so that the policy of the Department has always been to concentrate its energies on a few of the most serious pests and to assist all other inquirers with advice. This policy has been successfully carried out and the damage done by the two principal pests of the province, the potato moth and surface caterpillar, is being considerably reduced. At the same time a steadily increasing number of reports of damage are being received, so that it has become increasingly apparent that something must be done to assist the public to help themselves.

At the present time there is a large amount of information available which would enable the cultivating classes to reduce the losses they suffer from crop pests, but it is spread through the publications of the various Departments of Agriculture, and it is by no means easy for the non-technical reader to obtain or understand all the information available concerning any pest in which he is interested. It is to put this information in a simple and compact form that the present handbook has been compiled, and it is to be hoped that the large educated population of these Provinces will

NOTE.—The preparation of this handbook was completed in March 1912 but its publication has been delayed on account of difficulties in obtaining funds due to the repartition of Bengal.

make use of it in assisting the cultivators of the land in whom they profess so much interest.

As regards the *use which can be made of the handbook*, the arrangement of the book is intended to enable educated persons interested in agriculture to identify any pest and to learn all such facts concerning it as will enable them to cope with it successfully. With this object the pests have been first grouped under the crops to which they do damage, and have then been subdivided into further groups according to the nature of the damage done by them. In the list of pests on pages 10 to 23 are given all the pests which are likely to be found on each of the commoner crops, but in the body of the handbook each pest is only dealt with once under the crop chiefly attacked by it. Plates have been included where possible to facilitate the identification of the pest. The account of each pest is complete in itself, and appendices have been added summarizing the best remedies which are generally applicable. References have been given under each pest to the literature concerning it which is available in India.

The first principle to be remembered in dealing with plant diseases is that "prevention is better than cure." It usually happens that the presence of a pest is not noticed until it has increased to such an extent that it cannot be destroyed except at heavy expense. A good agriculturist will note each year the first appearance of any pest which is known to do serious damage in his locality and will take steps to prevent its increase to destructive proportions. He will find that clean cultivation, proper rotation of crops, and the clearing of any waste land round those crops will be valuable aids to him in this work.

In the case of *fungus diseases*, it must be understood that a parasitic fungus is a specialized type of plant which has adapted itself to grow either inside (such as the wilt disease of Rahar and Rust of wheat) or on the outside (such as powdery mildew on pea) of other plants and to take all its nourishment from its host plant. In most of the pests dealt with here the fungus grows inside its host plant and only appears on the surface when it has finished its vegetative existence and is producing ripe fruits. The difficulty of dealing with such pests can be imagined when one considers what would be the effect if the ordinary weeds of cultivation grew under the soil and were only noticeable when they were in fruit and had done all the damage of which they were capable.

Many fungi produce a number of different kinds of "seeds" for different purposes, among these may be mentioned the *conidia* and *uredos-*

pores which are produced by the fungus while its host plant is in active growth, and which serve to spread the fungus from the attacked plant to other plants growing round it, their spread being usually much increased by cloudy or misty weather. At harvest time when the host plant is ripening the fungus produces thick walled resting spores or *telutospores* which can remain dormant until the next sowing season, when they also germinate in the soil and again infect the seedlings of their host plant. The vegetative portion of some fungi may also remain alive through the resting season as *sclerotia* or compact bundles of filaments.

Enough has been said to show that it is usually useless to attempt to minimize the damage done to crops by fungi after the presence of the fungi has become apparent. In the case of fungi which live on the surface of plants it is possible to reduce the damage done by the fungus by spraying with a suitable fungicide. This should be done when the fungus first appears and can usually only be economical in the case of valuable garden crops. In the case of fungi which live within the host something may sometimes be done towards checking the spread of the disease by removing the diseased plants or by the adoption of a suitable rotation of crops, such that any one crop is grown on the same land at sufficiently long intervals to ensure that the majority of the resting spores germinate and die while the land is still under a crop not attacked by them. Where the seed or cuttings of any crop are known to carry the fungus, the seed should be disinfected or care should be taken to plant only healthy seed. For many of these diseases the only hope of real improvement seems to lie in the selection of disease resistant types.

In the case of *damage done by insects*, the work of preventing the damage is simpler as the increase in number of the pest can be watched from its first appearance. Every agriculturist should be able to recognize the chief pests which damage his crops and should be able to prevent them multiplying to destructive proportions by judicious picking or by other means. To assist him in this, a brief account is here given of the characters and life-history of the more important groups of insects. Insects differ considerably in their structure and habits, they can however be distinguished from other animals by the fact that they have three pairs of true legs. Their bodies consist of three parts, the Head, the Thorax carrying the legs and wings, and the Abdomen. The majority of insects undergo a series of changes (metamorphoses) and usually pass through four stages in their life cycle. (1) The egg stage, (2) the larval stage, (3) the pupal stage, and (4) the adult stage.

(1) *Egg*.—Eggs are of various shapes, colours, and sizes, but are generally small. They are not cared for by the parent insect but are generally laid on or near their food plant.

(2) *Larva*.—When the eggs are mature, the young ones inside them, which are known as larvæ, emerge by breaking the shells. In this stage their main business is to eat voraciously and to grow rapidly. They are generally long, soft, cylindrical creatures, hairy or hairless, with heads furnished with jaws or hooks or some other device for gathering food; they may be legless or have three pairs of short jointed legs behind the head in addition to one to several pairs of sucker feet beneath the abdomen. In this stage they never have well developed wings. They eat vigorously and at varying intervals change their skins to allow for a further increase in size. This stage may be very short or very long, depending upon the habit of the insects and on the climatic and other conditions. A butterfly or moth larva is called a *caterpillar*, that of a bee or beetle a *grub*, and of a fly a *maggot*.

(3) *Pupa*.—When the larva has finished feeding and is full grown it changes its skin and turns into a pupa. In this stage it is perfectly defenceless and usually remains concealed or protected from its enemies in a silken covering, in a cell, a nest, or in the ground; these cases or cells are prepared by the larva itself before the last change of skin. An insect in this stage does not eat anything. The pupa of a butterfly or moth is known as a *chrysalis*.

(4) *Imago or Adult*.—During the outwardly inactive pupal period profound changes go on in the body of the insect and at the end of a certain time, which again depends on the habits of the insect and climatic conditions, the adult insect emerges and is generally found to be provided with one or two pairs of wings. Reproduction is the principal business of this period.

The above remarks apply only to one class of insects in which the different stages are extremely unlike. They hold good in the case of butterflies, moths, flies, mosquitoes, beetles, wasps, etc., but there is another class of insects, such as the grasshoppers, cockroaches, bugs, etc., in which the changes are not so pronounced. In these insects the larva (known as a *nymph* in this class of insects) looks more or less like the adult insect, except that it is smaller in size and that it has no wings or is provided only with wing pads in place of perfect wings. In this class there is no definite inactive pupal stage. A nymph goes on feeding and changing its skin at intervals until it becomes full grown when it is capable of reproduction.

The *chief classes of insects* can be differentiated by the following characteristics :—

• *Orthoptera* (Grasshoppers, Crickets, Praying Mantis, Leaf and Stick insects, Cockroaches) have biting mouth parts. The first pair of wings is narrow and leathery with sharp edges and projects beyond the end of the body, the second pair is membranous, folds up beneath the first, and has straight veins. The young differ from the adults only in size, colour, and the absence of wings and reproductive organs. The grasshoppers and some crickets are the chief pests found in this group. (Plates III & X).

Hymenoptera (Bees, Ants, Wasps, Sawflies, Ichneumons and Braconids, Chalcids, etc.), have either biting or lapping mouth parts. Both pairs of wings are small transparent and with few veins, the forewings being slightly larger than the hind wings. They are provided with an egg-laying tube at the end of their bodies. In all cases the metamorphosis is very complete, the larva being usually a helpless grub. The sawfly has an active larva, which can be distinguished from a true caterpillar by its having 3 pairs of clawfeet and 6-8 pairs of suckerfeet. Sawflies and some ants are the only pests in the groups, while the Ichneumons, Braconids, Chalcids, assist the agriculturist by being parasitic on other insects. (Plate XXIII).

Coleoptera (Beetles) have biting mouth parts. The first pair of wings are horny or shell-like and are only used as a sheath for the folded lower wings. The larvæ, or grubs, have a distinct head and may have 3 pairs of true legs but no suckerfeet. Weevil larvæ have brownish heads and no legs and are much curved; the mature weevils have well marked snouts. Adult beetles are usually long lived. The chief pests in this group are the Rice Hispa, *Epilachna* beetles, Blister beetles, Palm beetles, Pumpkin beetles, Cockchafer and some weevils. Among beneficial insects are the large predaceous ground beetles and the Ladybird beetles which usually feed on aphids. The grubs of Ladybird beetles are usually found on leaves attacked by aphids and should not be destroyed as they feed on the aphids. (Plates IV, VIII, XLIV, XLVII, LII & LIII).

Lepidoptera (Butterflies and Moths) have sucking mouth parts. The two pairs of wings are of nearly equal size and covered with scales. The imago (or adult insect) obtains its food from flowers or plant sap, and in a large number its life is usually brief. The larvæ, or caterpillars, have biting mouth parts, are herbivorous and have three pairs of clawfeet and from two to five pairs of suckerfeet. Butterflies (*vide* Plate L) are day-flying insects; they hold their wings above their backs when at rest and

their antennæ are rigid and knobbed at the tip : their pupæ are generally attached openly to leaves, etc. Moths fold their wings above their backs and do not fly by day : they generally pupate in cocoons or in concealment and do not have knobbed antennæ. Among butterflies very few pests are found. The common butterfly pests are Cabbage butterfly, Anar butterfly, Lemon butterfly : among moths are found the majority of our chief pests (Plates I, II, VI, XI, XXI, XXV, XXVI, &c.). The damage is always done by the caterpillars and seldom by the adult butterflies and moths.

Diptera (Flies, Mosquitoes, etc.), have sucking mouth parts. They have one pair of wings, the hinder pair being reduced to knobs. The length of the life of the adult is often greater than that of the larva. The larvæ or maggots are legless and usually have no well marked head. The larvæ are usually scavengers but may be parasitic on insects or animals. The pupæ are either bare, with their limbs free, or they may be enclosed within the last larval skin. The chief pests in this group are the fruit flies and the stem and pod flies.

Hemiptera (Bugs) have sucking mouth parts. They have four wings, the basal half of the upper wings is often thickened and the wings overlap. The young differ from the adults only in colour, size and absence of well developed wings. In all stages the insects obtain their nourishment by suction either from the sap of plants or the blood of animals. In the aphidæ (or plant lice) the females produce living young without the intervention of the male, and these in turn may commence to produce young so that their numbers increase very rapidly. The chief pests in this group are the plant bugs, leaf hoppers, psyllas, scale insects, mealy bugs, mealy wings, etc. (Plates XII, XXIV, XXXII).

The prevention of damage by insect pests can usually be effected by proper farm management. The crop on well manured land in good condition is more likely to resist an attack than that on poor weedy soil. The destruction of weeds by clean cultivation will diminish the number of host plants available for the insects. The removal of heaps of rubbish from the fields will reduce the number of hiding places available for the pests. Summer ploughing will kill eggs or pupæ in the land by exposing them to the sun. Stray plants of any crop should not be allowed to remain in the field after the main crop has been cleared off. Cereals such as juar, paddy, maize should not be allowed to throw up fresh shoots after harvest, as they provide a home for cereal pests when nothing else is available, and so will enable these pests to live

through until the next sowing season. When it is known that some crops are particularly liable to damage by a particular pest it is often advisable to grow an early sown quick growing trap crop on which the pest will lay its eggs; the trap crop can then be destroyed. Fowls may be kept and allowed to wander over the land, as they are also of considerable assistance in keeping down the numbers of insects; insectivorous birds should also be encouraged. A look-out should always be kept for the first appearance of dangerous pests, and if necessary their numbers should be kept in check by judicious hand-picking.

If these precautions have not been carried out effectively and a pest has succeeded in establishing itself it is necessary to take sterner measures. In the first place, the insect must be identified and all the information available concerning its life-history should be studied with a view to finding any vulnerable points for attack. Any action taken should be with the object of killing the insects when most can be killed at one time, and with the object of preventing egg-laying at all costs. Whenever a pest first appears hand-picking is often the best means of dealing with it. For active insects which jump when disturbed bagging is effective. For insects which are attracted by lights at night light traps are of value. Moths which fly by night and feed in the adult stage before laying their eggs may be caught and destroyed by means of Andres Maire traps. Insects which hide in the soil can be destroyed by irrigation. Spraying is not usually economical, but in case it is used it must be remembered that a "Stomach" poison (Lead chromate) should be used only for insects which actually eat the leaves, and a "Contact" poison (Crude oil emulsion) is effective for all insects including those which suck the sap of the plant.

This handbook has been compiled by Mr. S. K. Basu, M.A. (Camb.), Asst. Professor of Mycology, and Mr. H. L. Dutt, M.Sc.A. (Cornell), Asst. Professor of Entomology, from the publications of the Imperial and other Agricultural Departments in India and other standard works. This Department is greatly indebted to Dr. E. J. Butler, M.B., F.L.S., Imperial Mycologist; and Mr. T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S., Officiating Imperial Entomologist, for reading through the manuscript on its completion and for advice regarding the illustrations. A list of plates kindly loaned by the Imperial Department is appended.

E. J. WOODHOUSE, M.A., F.L.S..

Economic Botanist to the Govt. of Behar and Orissa.

LIST OF ENTOMOLOGICAL PLATES LOANED BY THE IMPERIAL ENTOMOLOGIST.

LIST A.

These plates have appeared in the publications noted against them—

Serial No	Plate.	Appeared in
1	<i>Nymphula depunctalis</i> ...	. I. I. L.
2	<i>Leptocorisa varicornis</i> ...	. Mem. D. Ag. I, Vol. II, No 1. (Ent)
3	<i>Anomala varians</i> ...	... I. I. L.
4	Pests of pulses ...	. F. P.
5	<i>Exelastis atomosa</i> .	... I. I. L.
6	<i>Acherontia styx</i> ..	I. I. L.
7	<i>Antigastra catalaunalis</i> ...	... I. I. L.
8	<i>Athalia proxima</i> ...	... Mem. D. Ag. I, Vol. I, No. 6. (Ent)
9	<i>Ophiusa melicerte</i> .	.. Mem. D. Ag. I, Vol. II, No 4. (Ent.)
10	<i>Dichocrocis punctiferalis</i> ..	I. I. L.
11	<i>Sylepta derogata</i> ...	.. Mem. D. Ag. I, Vol. III, No 3. (Ent)
12	<i>Earias insulana</i> , &c. ...	. I. I. L.
13	<i>Dysdercus cingulatus</i> ...	Mem. D. Ag. I, Vol. III, No. 3 (Ent)
14	Jute pests ...	F. P.
15	<i>Diacrisia obliqua</i> ...	. I. I. L.
16	<i>Prodenia litura</i> ...	.. Mem. D. Ag. I, Vol. II, No 5 (Ent.)
17	<i>Gnorimoschema heliopa</i> ..	.. A. J. I., Vol. III, Pt. 1
18	Borers of sugarcane ..	... F. P.
19	<i>Phthorimæa operculella</i> ...	. I. I. L.
20	Vegetable pests ...	.. F. P.
21	Pests of brinjal ...	... F. P.
22	<i>Cylas formicarius</i> .	I. I. L.
23	<i>Oryctes rhinoceros</i> ...	. Mem. D. Ag. I, Vol. II, No. 10. (Ent)
24	<i>Rhynchophorus ferrugineus</i> ..	.. Mem. D. Ag. I, Vol. II, No. 10. (Ent.)
25	<i>Papilio demoleus</i> ...	... F. P.
26	Blister beetles ..	... I. I. P.

LIST B

These plates have not been previously published, but are intended for use in Memoirs in course of preparation by the Imperial Entomologist.

Serial No.	Plates.
1	<i>Spodoptera mauritia</i> .
2	<i>Cirphis unipuncta</i> .

Serial No.	Plate.
3	Hieroglyphus furcifer.
4	Hispa ænescens.
5	Schoenobius bipunctifer.
6	Chrotogonus trachypterus.
7	Sesamia uniformis.
8	Wheat aphid [Macrosiphum (siphonophora) granarium].
9	Mustard aphid.
10	Phycita infusella.
11	Gelechia gossypiella.
12	White ants (Termes).
13	Epilachna dodecastigma and E. vigintioctopunctata.

LIST OF MYCOLOGICAL PLATES LOANED BY THE IMPERIAL MYCOLOGIST.

LIST A.

Serial No.	Plate	Appeared as
1	Puccinia glumarum	... Plate II in Mem. D. Ag. I., Vol. I, No. 2 (Bot.)
2	Sclerospora graminicola	... „ I in Mem. D. Ag. I., Vol. II, No. 1 (Bot.)
3	Bud-rot of Palms ...	... „ III in Mem. D. Ag. I., Vol. III, No. 5 (Bot.)
4	Soft-rot of ginger...	... in A. J. I., Vol. VI, Plate 2.
5	Red-rot of sugarcane	... in A. J. I., Vol. II, Plate 2.
6	Smut on sugarcane	.. Plate IV in Mem. D. Ag. I., Vol. I, No. 3 (Bot.)
7	Phytophthora Colocasiæ	... „ I in Mem. D. Ag. I., Vol. V, No. 5 (Bot.)

LIST B.

These plates have not previously been published, but are intended for use in Memoirs in course of preparation by the Imperial Mycologist.

- 1 Ustilaginoidea Oryzæ.
- 2 Ustilago Tritici.
- 3 Rahar wilt.
- 4 Powdery mildew of pea.
- 5 Rust of pea.
- 6 Ripe-rot of fruits.
- 7 Sooty mould of citrus plants.

ABBREVIATIONS.

Mem. D. Ag. I.=Memoir of the Department of Agriculture in India.
 Bull. D. Ag. I.=Bulletin of the Department of Agriculture in India.
 A. J. I.=The Agricultural Journal of India.
 F. P.=“Fasalar Poka”
 I. I. L.=Indian Insect Life
 I. I. P.=Indian Insect Pests.
 B. Q. J.=Bengal Quarterly Journal.
 B. A. J.=Behar Agricultural Journal.

LIST OF THE CROP PESTS OF BENGAL.

N.B.—Where the word *Minor* is inserted in place of the reference number the pest is one of very minor importance.

I.—CEREALS.

A. Paddy—*Oryza sativa*.

LEAFLET.

INSECTS.

(a) Leaf-eating—

<i>Spodoptera mauritia</i> , Boisd.	...	Rice swarming caterpillar.	...	1
<i>Cirphis unipuncta</i> , Haw.	...	Army worm	..	2
<i>Hieroglyphus furcifer</i> , Serv.	...	Rice grasshopper	..	3
<i>Hispa cenescent</i> , Baly.	...	Rice hispa	...	4
<i>Melanites ismene</i> , Cram.	...	Rice butterfly	..	Minor.
<i>Oxya velox</i> , F.	...	Small rice grasshopper (similar to)	...	3
<i>Amsacta lactinea</i> , Cram.	...	Orange banded amsacta	...	21

(b) Leaf-rolling—

<i>Nymphula depunctalis</i> , Guen.	...	Rice case worm	...	5
<i>Cnaphalocrocis medinalis</i> , Guen.	...	Rice leaf roller	...	Minor.
<i>Ancylolomia chrysographella</i> , Zell.	...	Rice caterpillar	..	Minor.
<i>Parnara mathias</i> , F.	...	Rice skipper	...	Minor.

(c) Stem-boring—

<i>Schoenobius bipunctifer</i> , Wlk.	...	Rice stem borer	...	6
<i>Sesamia (nonagria) uniformis</i> , Ddgn.	...	Pink borer	...	14
<i>Chilo simplex</i> , Butl.	...	Moth borer	...	56

(d) Grain-sucking—

<i>Leptocorisa varicornis</i> , F.	..	Rice bug	...	7
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(e) Leaf and stem sucking—

<i>Liburnia</i> , Sp.	...	Rice leaf hopper	...	8
<i>Ripersia sacchari</i> , Gr.	...	Rice mealy bug	...	Minor.

(f) Flower-eating—

<i>Cantharis acteon</i> , Cast.	...	Blue blister beetle	...	9
<i>Cantharis rousi</i> , Cast.	...	Brown blister beetle	...	9
<i>Mylabris side</i> , F.	...	Banded blister beetle	...	9
<i>Chiloloba acuta</i> , Wied.	...	Green chafer (similar to)	..	10

(g) Root-eating—

<i>Anomala varians</i> , Oliv.	...	Cockchafer	...	10
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A. Paddy—<i>Oryza sativa</i>—contd.					LEAFLEMT.
A disease of uncertain origin ...					11
FUNGUS.					
<i>Ustilaginoides oryzae</i> , Pat. ... False Smut of paddy					12
B. Wheat—<i>Triticum vulgare</i>.					
INSECTS.					
(a) Leaf-eating—					
<i>Epacromia dorsalis</i> , Thunb ... White banded grasshopper (similar to)					13
<i>Chrotogonus trachypterus</i> , Bl. ... Surface grasshopper					13
<i>Tanymecus indicus</i> , Fst. ... Surface weevil					Minor.
(b) Stem-boring—					
<i>Sesamia (nonagria) uniformis</i> , Ddg. ... Pink borer					14
(c) Sucking—					
<i>Siphonophora granarium</i> , Kby. .. Wheat aphid					15
(d) Root-cutting—					
<i>Termes</i> , Sp. ... White ant					59
(e) Stem-cutting—					
<i>Agrotis ypsilon</i> , Rott. ... Greasy surface caterpillar					25
FUNGUS.					
<i>Puccinia graminis</i> , Pers. ... Rust					16
<i>Puccinia glumarum</i> , Erik & Henning Rust					16
<i>Puccinia triticina</i> , Erik ... Rust					16
<i>Ustilago tritici</i> , Jens. ... Smut					17
C. Barley—<i>Hordeum vulgare</i>.					
INSECTS.					
(a) Sucking—					
<i>Siphonophora granarium</i> , Kby. ... Wheat aphid					15
(b) Root-cutting—					
<i>Termes</i> , Sp. ... White ant					59
(c) Stem-cutting—					
<i>Agrotis ypsilon</i> ... Greasy surface caterpillar					25
FUNGUS.					
<i>Puccinia graminis</i> , Pers. ... Rust					16
<i>Puccinia glumarum</i> , Erik & Henning Rust					16
<i>Ustilago Hordei</i> , Kell & Sw. ... Smut					17
D. Oats—<i>Avena sativa</i>.					
FUNGUS.					
<i>Puccinia lolii</i> , Niels ... Rust					16
<i>Ustilago Avenae</i> , (Pers.) Jens ... Smut					17

INSECTS.

(a) Leaf-eating—

<i>Chrotogonus trachypterus</i> , Bl.	.. Surface grasshopper	...	13
<i>Marasmia trapezalis</i> , Guen.	... Maize leaf-roller	..	Minor.
<i>Melanites ismene</i> , Cram.	.. Rice butterfly	...	Minor.
<i>Cirphis unipuncta</i> , Haw.	Army worm	...	2
<i>Amsacta lactinea</i> , Cram.	... Orange banded amsacta	...	21
<i>Diacrisia obliqua</i> , Wlk.	.. Behar hairy caterpillar	...	47

(b) Leaf sucking—

<i>Aphis adusta</i> , Zehnt. Juar aphid (similar to)	...	15
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(c) Stem-boring—

<i>Chilo simplex</i> , Butl.	...	Moth borer	...	56
<i>Sesamia uniformis</i> , Ddgn.	...	Pink borer	...	14

(d) Flower-eating—

<i>Cantharids</i>	Blister beetles	...	9
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(e) Grain-eating—

<i>Stenachroia elongella</i> , Hmp.	...	Web caterpillar	...	Minor.
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(f) Grain-sucking—

<i>Nezara viridula</i> , Linn.	...	Green bug	...	Minor.
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FUNGUS.

<i>Sclerospora graminicola</i> , Scroet	...	Green ear or leaf shredding disease	...	18
<i>Puccinia purpurea</i> , Cooke	...	Rust	...	19
<i>Cintractia Sorghi-vulgaris</i> (Tul) Clint	Smut	...	...	20

F. *Maize*—*Zea mays*.

INSECTS.

(a) Leaf-eating—

<i>Chrotogonus trachypterus</i> , Bl.	...	Surface grasshopper	...	13
<i>Hieroglyphus furcifer</i> , Serv.	...	Rice grasshopper	...	3
<i>Amsacta lactinea</i> , Cram.	...	Orange banded amsacta	...	21
<i>Cirphis unipuncta</i> , Haw.	...	Army worm	...	2
<i>Spodoptera mauritia</i> , Boisd.	...	Rice swarming caterpillar	...	1
<i>Melanites ismene</i> , Cram.	...	Rice butterfly	...	Minor.
<i>Diacrisia obliqua</i> , Wlk.	...	Behar hairy caterpillar	...	47
<i>Laphygma exigua</i> , Guen	...	Indigo caterpillar	...	49

(b) Leaf-sucking—

<i>Liburnia psylloides</i> , Leth.	...	Maize fly	...	Minor.
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(c) Leaf-rolling—

<i>Marasmia trapezalis</i> , Guen.	...	Maize leaf roller	...	Minor.
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(d) Stem-boring—

<i>Chilo simplex</i> , Butl.	...	Moth borer	...	56
<i>Sesamia uniformis</i> , Ddgn.	...	Pink borer	...	1

(e) Stem-cutting—

<i>Termes</i> sp.	...	White ant	...	59
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G. Millets—The following are the chief millets grown in our area —

LEAFLET.

<i>Sama, Kheri, Suwan</i>	<i>Panicum frumentaceum.</i>
<i>Chena</i>	...	...	<i>Panicum miliaceum.</i>
<i>Kodo</i>	...	...	<i>Paspalum scrobiculatum</i>
<i>Marua</i>	..	...	<i>Eleusine coracana.</i>
<i>Kaoni</i>	...	...	<i>Setaria italica.</i>
<i>Bajra</i>	...	...	<i>Pennisetum typhoideum.</i>

INSECTS.

(a) Leaf-eating —

<i>Spodoptera mauritia</i> , Boisd.	..	Rice swarming caterpillar	...	1
<i>Girphis unipuncta</i> , Haw.	...	Army worm	...	2
<i>Diaerisia obliqua</i> , Wlk.	...	Behar hairy caterpillar	...	17
<i>Chrotogonus trachypterus</i> , Bl.	...	Surface grasshopper	...	13
<i>Hieroglyphus furcifer</i> , Serv.	...	Rice grasshopper	...	3

(b) Leaf-rolling—

<i>Parnara mathias</i> , F.	...	Rice skipper	...	Minor.
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(c) Stem-boring—

<i>Sesamia uniformis</i> , Ddgn.	...	Pink borer	...	14
<i>Chilo simplex</i> , Butl.	..	Moth borer	...	56

(d) Grain-sucking—

<i>Leptocoris varicornis</i> , F.	...	Rice bug	...	7
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(e) Leaf and stem-sucking—

<i>Liburnia</i> , Sp.	...	(Similar to)	...	8
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(f) Flower-eating—

<i>Cantharids</i>	...	Blister beetles	...	9
<i>Chiloloba acuta</i> , Wied.	...	Green chafer (similar to)	...	10

(g) Grain-eating—

<i>Stenachroia elongella</i> , Hmp.	...	Web caterpillar	...	Minor.
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FUNGUS.

<i>Sclerospora graminicola</i> , Schroet	...	Green ear disease or leaf shredding disease	...	18
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II.—PULSES.

The following are the more important pulse crops of our area :—

Gram	<i>Cicer arietinum.</i>
Pea	...	...	<i>Pisum sativum</i> and <i>arvense.</i>
Lentil	...	...	<i>Lens esculenta.</i>
Mung	...	...	<i>Phaseolus radiatus.</i>
Urid	...	...	<i>Phaseolus mungo.</i> var. <i>Roxburghi.</i>
Khesari	...	...	<i>Lathyrus sativa.</i>
Arhar	...	...	<i>Cajanus indicus.</i>
Kulthi	...	...	<i>Dolichos biflorus.</i>
Cowpea	...	...	<i>Vigna catianga.</i>

II.—PULSES—contd

LEAFLET.

Soy bean . . .	...	Glycine soya.	
Country bean . . .	...	Dolichos lablab	
Broad bean .. ..	..	Vicia faba.	
INSECTS.			
(a) Leaf-eating—			
<i>Laphygma (caradrina) erigua</i> , Guen.	Indigo caterpillar .	...	49
<i>Prodenia litura</i> , F.	...	Tobacco caterpillar	52
<i>Diacrisia obliqua</i> , Wlk.	...	Behar hairy caterpillar	47
<i>Plusia</i> spp.	...	.....	22
(b) Leaf-rolling—			
<i>Eucelis critica</i> , Meyr.	...	Tur leaf roller	Minor.
(c) Leaf sucking—			
<i>Aphis cardui</i> , L.	...	Tur aphid (similar to)	15
(d) Pod-eating and sucking—			
<i>Chloridea obsoleta</i> , F.	...	Gram caterpillar	23
<i>Catocala prorsa</i> , Fbr.	...	Turpod butterfly	Minor.
<i>Exelastis atomosa</i> , Wlsm	...	Tur plume moth	24
<i>Maruca testulalis</i> , Gey.	...	Mung pod borer	Minor.
<i>Etiella zinckenella</i> , Tr.	...	Khesari-pod borer	Minor.
<i>Plusia nigrisigna</i> , Wlk.	...	Gram semi-looper	22
<i>Riptortus linearis</i> , F.	...	.....
(e) Stem-cutting—			
<i>Agrotis ypsilon</i> , Rott.	...	Greasy surface caterpillar	25
(f) Stem-boring—			
<i>Agromyza</i> , sp.	...	Pea stem fly	Minor.
FUNGUS.			
<i>Fusarium udum</i> , Butl.	...	Wilt disease	26
<i>Peronospora Viciae</i> , de Barry	...	Downy mildew	27
<i>Erysiphe Polygoni</i> , D.C.	...	Powdery mildew	28
<i>Uromyces Fabae</i> , de Barry	...	Rust	29
<i>Uromyces appendiculatus</i> , Link	...	Rust	29
<i>Cercospora cruenta</i> , Sacc.	...	Leaf spot disease	30
<i>Cercospora Dolichii</i> , E. & E.	...	Leaf spot disease	30

III.—OILSEEDS.

A. Linseed—*Linum usitatissimum*.

INSECTS.

(a) Leaf-eating—			
<i>Diacrisia obliqua</i> , Wlk	...	Behar hairy caterpillar	47
<i>Prodenia litura</i> , F.	...	Tobacco caterpillar	52
<i>Plusia orichalcea</i> , F.	...	Mustard semi-looper	22
<i>Laphygma exigua</i> , Guen.	...	Indigo caterpillar	49
(b) Stem-cutting—			
<i>Agrotis ypsilon</i> , Rott.	...	Greasy surface caterpillar	25

B. Til—*Sesamum indicum*.

LEAFLET.

INSECTS.

(a) Leaf-eating—

<i>Diacrisia obliqua</i> , Wlk.	... Behar hairy caterpillar	..	47
<i>Acherontia styx</i> , F.	... Til hawk moth	..	31
<i>Amsacta lactinea</i> , Cram.	... Orange banded amsacta	...	21

(b) Leaf-rolling—

<i>Antigastra catalaunalis</i> , Dp.	.. Til leaf roller	...	32
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C. Mustard, Rape, &c.—*Brassica* spp.

INSECTS.

(a) Leaf-eating—

<i>Athalia proxima</i> , Kl.	... Mustard sawfly	...	33
<i>Plutella maculipennis</i> , Curt.	.. Diamond back moth	..	31
<i>Plusia</i> sp.	... ..	...	22

(b) Leaf and pod-sucking—

<i>Aphis brassicae</i> , D.	... Mustard aphid	...	35
<i>Bagrada picta</i> , F.	... Mustard bug	...	Minor

(c) Flower and pod-eating—

<i>Crocidolomia binotalis</i> , Zell.	... Cabbage caterpillar	..	36
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(d) Stem-cutting.—

<i>Agrotis ypsilon</i> , Rott.	... Greasy surface caterpillar	..	25
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FUNGUS.

<i>Polydesmus erituosus</i> , Kuhn.	... Leaf spot disease	..	37
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D. Castor—*Ricinus communis*.

INSECTS

(a) Leaf-eating.—

<i>Ophiura meliceris</i> , Dr.	.. Castor semi-loopers	...	38
<i>Prodenia litura</i> , F.	.. Tobacco caterpillar	...	52
<i>Diacrisia obliqua</i> , Wlk.	... Behar hairy caterpillar	...	47
<i>Pericallia ricini</i>	... Castor hairy caterpillar	...	Minor.
<i>Eryolus merione</i> , Cr.	... Castor butterfly	...	Minor.
<i>Trabala vishnu</i> , Lef.	.. Castor wooly caterpillar	...	Minor.
<i>Euproctis fraterna</i> , Mo	... Castor caterpillar	...	Minor.

(b) Seed-eating—

<i>Dichocrocis punctiferalis</i> , Guen	... Castor seed caterpillar	...	39
<i>Chloridea obsoleta</i> , F.	... Gram caterpillar	..	23

(c) Leaf-sucking—

<i>Aleurodes (ricini)</i>	... Castor mealy wing	...	40
<i>Empoasca notata</i> , Melich.	... Castor leaf hopper	..	Minor.
<i>Tetranychus talaricus</i>	... Red spider	...	Minor.

III.—OILSEEDS—contd.

H. Groundnut—*Arachis hypogaea*.

LEAFLET.

INSECTS.

(a) Leaf-eating—			
<i>Diacrisia obliqua</i> , Wlk...	...	Behar hairy caterpillar	47
<i>Prodena litura</i> , F. ...	...	Tobacco caterpillar	52
<i>Amsacta lactinea</i> , Cram...	...	Orange banded <i>Amsacta</i>	21
(b) Leaf-rolling—			
<i>Anarsia ephipprias</i> , Meyr.	...	Groundnut leaf-roller	Minor.
(c) Root-cutting—			
<i>Termes</i> sp. ...	...	White ant	59

F. Sarguja—*Guizotia abyssinica*.

INSECTS.

(a) Leaf-eating—			
<i>Plusia orichalcea</i> , F. ...	...	Mustard semi-looper	22
<i>Euplexia conducta</i> , Wlk.	...	.....	Minor.
(b) Root-cutting—			
<i>Termes</i> sp. ...	...	White ant	59

G. Safflower—*Carthamus tinctorius*.

INSECTS.

(a) Leaf-eating—			
<i>Laphygma exigua</i> , Guen.	...	Indigo caterpillar	49

IV.—FIBRES.

A. Cotton—*Gossypium Spp.*

INSECTS.

(a) Leaf-eating—			
<i>Diacrisia obliqua</i> , Wlk. ...	...	Behar hairy caterpillar	47
<i>Chloridea assulta</i> , Guen...	...	.....	...
<i>Laphygma exigua</i> , Guen.	...	Indigo caterpillar	49
<i>Chrotogonus trachypterus</i> , Bl.	...	Surface grasshopper	13
<i>Epacromia dorsalis</i> , Thunb.	...	White banded grasshopper (similar to)...	13
<i>Acontia intersepta</i> , Guen.	...	.....	Minor.
<i>Mylocerus maculosus</i> , Desbr.	...	White weevil	Minor.
(b) Leaf-rolling—			
<i>Sylepta derogata</i> , F. ...	...	Cotton leaf roller	41
<i>Phycita infusella</i> , Mey. ...	...	Cotton bud caterpillar	42
(c) Boll-eating—			
<i>Earias insulana</i> , Boisd. ...	...	Green boll worm	43
<i>Earias fabia</i> , Stoll. ...	...	Spotted boll worm	43
<i>Gelechia gossypiella</i> , Saund.	...	Pink boll worm	44

A. Cotton—*Gossypium* spp —contd

LEAFLET.

INSECTS.

(d) Sucking—

<i>Dysdercus cingulatus</i> , F.	..	Red cotton bug	..	45
<i>Oryctes loetus</i> , Kby.	..	Dusky cotton bug	..	Minor.
<i>Aphis gossypii</i> , Glov.	..	Cotton aphid	..	46
<i>Empoasca (gossypii)</i>	..	Cotton leaf hopper	..	Minor
<i>Dactylopius nipes</i> , Mask...		Seed potato bug	..	Minor

(e) Stem-boring—

<i>Pemphres affinis</i> , Fst.	...	Cotton stem weevil	...	Minor.
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FUNGUS.

<i>Rhizoctonia violacea</i> , Tul.	...	Wilt disease	...	64
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B. Jute—*Corchorus capsularis* and *olitorius*.

INSECTS.

(a) Leaf-eating—

<i>Diacrisia obliqua</i> , Wlk.	...	Behar hairy caterpillar	...	47
<i>Amsacta lactinea</i> , Cram.	..	Orange banded amsacta	...	21
<i>Cosmophila sabulifera</i> , Guen.	...	Jute semi-looper	...	48
<i>Laphygma exigua</i> , Guen.	..	Indigo caterpillar	...	49
<i>Tarache crocata</i> , Guen.	Minor.

(b) Stem-boring—

<i>Apion</i> sp.	...	Jute stem weevil	...	50
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(c) Leaf-sucking—

Red spider	...	Red spider	...	Minor.
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(d) Pod-boring—

<i>Earias chromataria</i> , Wlk.	Minor
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(e) Leaf-mining—

<i>Trachys</i> sp.	...	Jute Buprestid	...	Minor.
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FUNGUS.

<i>Rhizoctonia violacea</i> , Tul.	...	Wilt disease	...	64
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C. Sann Hemp—*Crotolaria juncea*.

INSECTS.

(a) Leaf-eating and pod-boring—

<i>Diacrisia obliqua</i> , Wlk.	..	Behar hairy caterpillar	...	47
<i>Utetheisa pulchella</i> , L.	...	Red spotted ermine moth	...	51
Sann hemp flea beetle	Minor.

(b) Stem-boring—

<i>Laspeyresia pseudonectis</i> , Meyr.	...	Sann stem-borer	...	Minor.
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V.—SPICES, DRUGS, AND NARCOTICS.

A. Tobacco—*Nicotiana tabacum*.

INSECTS.

(a) Young plants—

<i>Chrotogonus trachypterus</i> , Bl.	...	Surface grasshopper	...	13
<i>Atractomorpha crenulata</i> , Sss.	...	Green surface grasshopper (similar to)	...	13

V.—SPICES, DRUGS AND NARCOTICS—contd.

A. Tobacco—*Nicotiana tabacum*—contd.

LEAFLET.

INSECTS.

(b) Leaf-eating—				
<i>Prodenia litura</i> , F.	...	Tobacco caterpillar	...	52
<i>Diacrisia obliqua</i> , Wlk.	...	Behar hairy caterpillar	...	47
<i>Chloridea assulta</i> , Guen.	...	Tobacco caterpillar (similar to)	...	52
(c) Stem-boring—				
<i>Gnorimoschema heliopa</i> , Low.	...	Tobacco stem-borer	...	53
(d) Seeds—				
<i>Chloridea obsoleta</i> , F.	...	Gram caterpillar	...	23
<i>Chloridea assulta</i> , Guen.	...	Tobacco caterpillar (similar to)	...	52
(e) Stem-cutting—				
<i>Agrotis ypsilon</i> , Rott.	...	Greasy surface caterpillar	...	25
<i>Brachytrypes achatinus</i> , St.	...	Large brown cricket	...	54
Bacterial disease	...	.....	...	65

B. Opium—*Papaver somniferum*.

INSECTS.

(a) Leaf-eating—				
<i>Laphygma exigua</i> , Guen.	...	Indigo caterpillar	...	49
<i>Prodenia litura</i> , F.	...	Tobacco caterpillar	...	52
<i>Chrotogonus trachypterus</i> , Bl.	...	Surface grasshopper	...	13
(b) Pod-eating—				
<i>Chloridea obsoleta</i> , F.	...	Gram caterpillar	...	23
<i>Chloridea assulta</i> , Guen.	...	Tobacco caterpillar (similar to)	...	52
(c) Stem-cutting—				
<i>Agrotis ypsilon</i> , Rott.	...	Greasy surface caterpillar	...	25
(d) Sucking—				
<i>Thrips</i>	...	.....	...	Minor.
(e) Root-cutting—				
<i>Termes</i> sp.	...	White ant	...	59

C. Chillies—*Capsicum acuminatum*.

Bacterial disease	65
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D. Ginger—*Zingiber officinale*.

FUNGUS.

<i>Pythium gracile</i> , Schenk.	55
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VI.—SUGAR.

A. Sugarcane—*Saccharum officinarum*.

INSECTS.

(a) Leaf-eating—				
<i>Hieroglyphus furcifer</i> , Serv.	...	Rice grasshopper	...	3

A. Sugarcane—*Saccharum officinarum*—contd.

LEAFLET.

INSECTS.

(b) Leaf-mining—

Phidodonta modesta, We. ... Sugarcane hispa (similar to) ... 4

(c) Boring—

Chilo simplex, Bl. ... Moth borer ... 56

Chilo auricula, Ddgn. ... Gold fringed moth borer ... *Minor.*

Scirpophaga auriflua, Z. ... Spotted white borer ... 57

Sesamia uniformis, Ddgn. ... Pink borer ... 14

(d) Roots—

Polyocha saccharella, Ddgn. ... Cane root borer ... 58

Anerastia ablutella, Zell. ... Green cane borer ... *Minor.*

Termes sp. ... White ant ... 59

Anomala varians, Oliv ... Cockchafer ... 10

Serica indica, Blanch. ... (similar to) ... 10

(e) Sucking—

Aleurodes barodensis, Mask. ... Lahi ... *Minor.*

Pyrilla lycaudes, Wlk ... Cane fly... ... *Do.*

Ripersia sacchari, Gr. ... Rice mealy bug ... *Do.*

Dactylopius sacchari, Ckll. ... Cane mealy bug ... *Do*

FUNGUS.

Colletotrichum falcatum, Went ... Red rot ... 60

Ustilago sacchari, Rab. ... Smut ... 61

VII.—DYES.

A. Indigo—*Indigofera sumatrana*.

INSECTS.

(a) Leaf-eating—

Chrotogonus trachypterus, Bl. ... Surface grasshopper ... 13

Laphygma exigua, Guen. ... Indigo caterpillar ... 49

Prodenia litura, F. ... Tobacco caterpillar ... 52

(b) Root and stem-cutting—

Brachytrypes achatinus, St. ... Large brown cricket ... 54

Termes sp. ... White ant ... 59

(c) Leaf-sucking—

Psylla isitis, Buck. ... Indigo psylla ... —

Indigo aphid ... (similar to) ... 35

VIII.—VEGETABLES.

A. Potato—*Solanum tuberosum*.

INSECTS.

(a) Stem-cutting—

Agrotis ypsilon, Rott. ... Greasy surface caterpillar ... 25

VIII.—VEGETABLES—contd

A Potato—*Solanum tuberosum*—contd.

LEAFLET.

INSECTS

(b) Sucking—

Nezara viridula, L. ... Green bug ... Minor.

(c) Affecting stored potato—

Phthorimæa operculella, Zell. ... Potato moth ... 62

Dactylopus nipæ, Mask. .. Seed potato bug ... Minor.

Potato Tingid Minor.

(d) Leaf-eating—

Epilachna 28-punctata, F. ... 28-spotted epilachna ... 66.

Prodenia litura, F. ... Tobacco caterpillar ... 52

FUNGUS.

Macrosporium solani, E. & M. .. Early blight ... 63

Rhizoctonia solani, Kuhn 64

Bacterial disease 65

B Pumpkins—*Gourds*, &c.

INSECTS.

(a) Leaf-eating—

Sphenarches caffer, Zell. ... Kaddu plume moth ... Minor.

Epilachna 28-punctata, F ... 28-spotted epilachna ... 66

Epilachna dodecastigma, Muls. ... 12-spotted epilachna ... 66

Aulacophora foreicollis, Kust. ... Red pumpkin beetle .. 67

Aulacophora excavata, By .. Black pumpkin beetle ... 67

Glyphodes indica, Saund. . Pumpkin caterpillar ... Minor.

(b) Fruit-boring—

Dacus cucurbitæ, Coq. ... Gourd fly (similar to) ... 74

(c) Flower-eating—

Blister beetles 9

FUNGUS.

Oidium, Sp. Powdery mildew ... 68

C. Cabbage and Cauliflower—*Brassica oleracea*.

INSECTS.

(a) Leaf-eating —

Plutella maculipennis, Curt. ... Diamond back moth ... 34

Laphygma exigua, Guen. ... Indigo caterpillar ... 49

Athalia proxima, Kl. ... Mustard sawfly ... 33

Prodenia litura, F. ... Tobacco caterpillar ... 52

Pieris brassicæ, L. ... Cabbage butterfly ... 69

(b) Stem and leaf-cutting :—

Agrotis ypsilon, Rott. ... Greasy surface caterpillar ... 25

Brachytrypes achatinus, St. ... Large brown cricket ... 54

C. Cabbage and Cauliflower—*Brassica oleracea*—contd.

LEAFLET.

INSECTS.

• (c) Sucking—

<i>Bagrada picta</i> , F.	...	Mustard bug	...	Minor.
<i>Aphis brassicae</i> , L.	...	Mustard aphid	...	35

(d) In seed bed—

<i>Chrotogonus trachypterus</i> , Bl.	...	Surface grasshopper	...	13
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FUNGUS.

<i>Polydesmus extuosus</i> , Kuhn.	...	Leaf spot disease	...	37
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D. Brinjal—*Solanum melongena*

INSECTS.

(a) Leaf-eating—

<i>Epilachna dodecastigma</i> , Muls.	...	12-spotted epilachna	...	66
<i>Eublemma olivacea</i> , Wlk.	...	Brinjal stem-borer	...	Minor.

(b) Leaf-sucking—

<i>Urentius echinus</i> , Dist.	..	Brinjal leaf bug	...	Minor.
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(c) Stem-boring—

<i>Euzophera pericella</i> , Rag.	..	Brinjal stem-borer	...	70
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(d) Shoot and fruit-boring—

<i>Leucinodes orbonalis</i> , Guen.	..	Brinjal fruit-borer	...	70
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Bacterial disease	65
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E. Tomato—*Lycopersicum esculentum*.

Bacterial disease	65
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FUNGUS.

<i>Gleosporium</i> , Sp.	Ripe-rot	...	76
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F. Sweet Potato—*Batatas edulis*.

INSECTS

(a) Leaf-eating—

<i>Amsacta lactinea</i> , Cram	Orange banded amsacta	...	21
<i>Diacrisia obliqua</i> , Wlk.	...	...	Behar hairy caterpillar	...	47
<i>Prodenia litura</i> , F.	...	...	Tobacco caterpillar	...	52
<i>Herse convolvuli</i> , L.	Sweet potato hawk moth	...	Minor.
			(similar to)	...	31

(b) Boring—

<i>Cylas formicarius</i> , F.	Sweet potato weevil	...	71
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(c) Roots—

<i>Termes</i> sp.	White ant	...	59
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G. Arum—*Colocasia antiquorum*.

FUNGUS.

<i>Phytophthora Colocasiae</i> , Racib	72
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IX.—FRUITS.

A. Mango—*Mangifera indica*.

INSECTS.

LEAFLET.

(a) Sucking—

<i>Idiocerus clypealis</i> , Leth.	... Small mango leaf hopper	... 73
<i>Idiocerus atkinsoni</i> , Leth.	... Mango leaf hopper	... 73
<i>Psylla cistellata</i> , Buck. ...	... Mango psylla	... Minor.
<i>Icerya minor</i> , Gr.		

(b) Fruit-boring—

<i>Dacus persicæ</i> , Rig. ...	... Mango and peach fly ...	... 74
<i>Cryptorhynchus gravis</i> , F.	... Northern mango weevil	... 75

(c) Stem-boring—

<i>Batocera rubra</i> , L. Mango-borer	... Minor.
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(d) Bark-tunnelling—

<i>Arbela tetraonis</i> , Moore Litchi-borer	... Minor.
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FUNGUS.

- <i>Gloeosporium</i> , Sp. Ripe-rot 76
<i>Capnodium mangiferum</i> , Cke.	... Black blight	... 77

B. Litchi—*Nephelium litchi*.

INSECTS.

(a) Leaf-rolling—

<i>Eriophyes</i> , Sp. Litchi leaf-roller	... Minor.
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(b) Bark-tunnelling—

<i>Arbela tetraonis</i> , Moore.	... Litchi-borer	... Minor.
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(c) Fruit-eating—

<i>Argyroplote illepide</i> (<i>Cryptophlebia carpophaga</i> , Wls.) Minor.
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C. Peach—*Prunus persica*.

INSECTS.

(a) In fruit—

<i>Dacus persicæ</i> , Rig Mango and peach fly	... 74
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D. Pomegranate—*Punica granatum*

INSECTS.

(a) In fruit—

<i>Virachola isocrates</i> , F. Anar caterpillar	... 78
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E. Orange, etc.—*Citrus Spp.*

INSECTS.

(a) Leaf-eating—

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(a) Insect-sucking—

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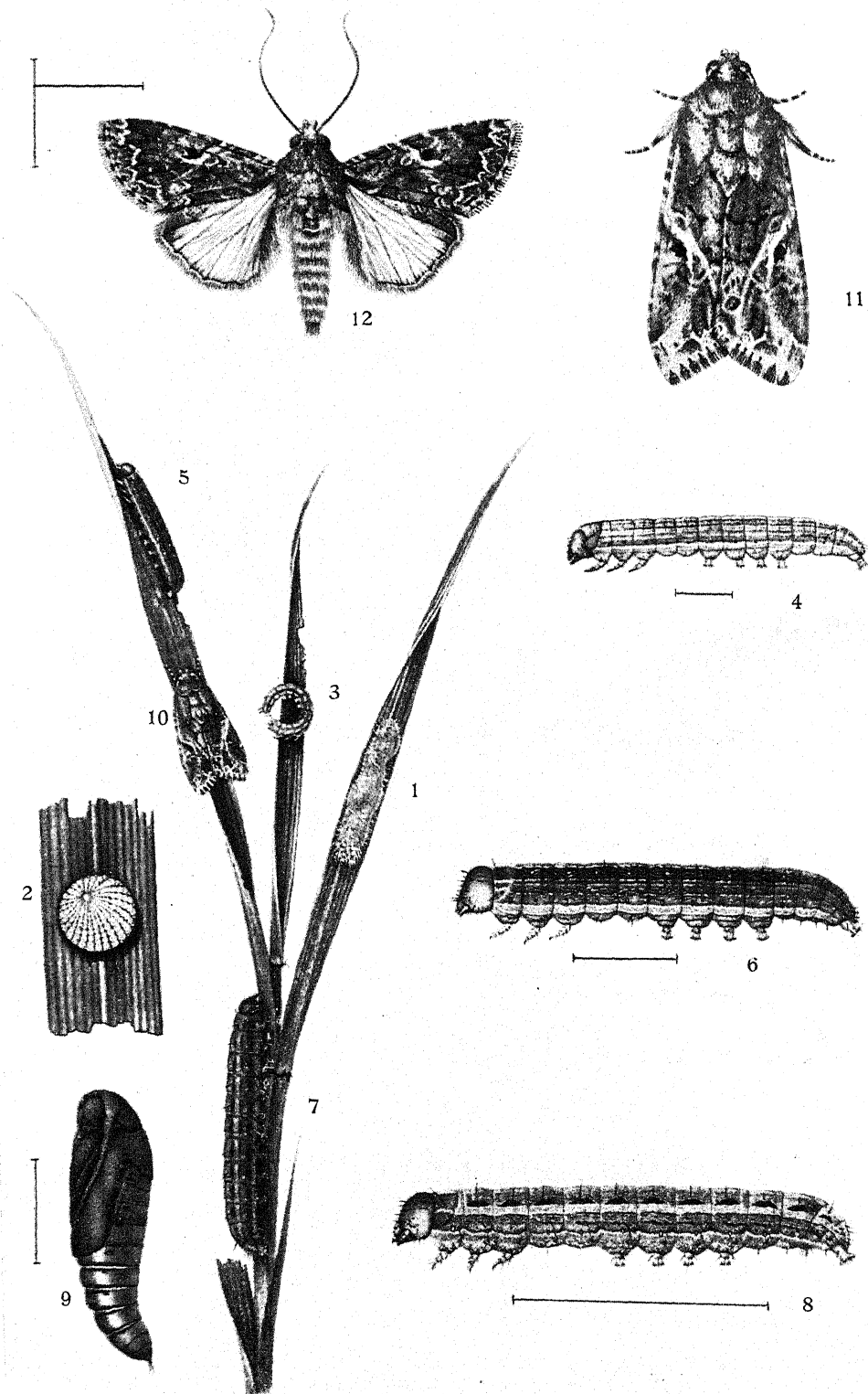
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RICE SWARMING CATERPILLAR.

Fig. 1.—Egg mass. Fig. 2.—One egg magnified. Fig. 3.—Young caterpillar coiled up. Fig. 4.—Young caterpillar magnified. Fig. 5.—Half-grown caterpillar. Fig. 6.—The same magnified. Fig. 7.—The full-grown caterpillar. Fig. 8.—The same magnified. Fig. 9.—Pupa. Fig. 10.—Moth sitting on plant. Fig. 11.—The same magnified. Fig. 12.—The same with wings expanded.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

I.—CEREALS.

Host : A. PADDY.—*Oryza sativa*.

VERN. NAMES.—Beng.—*Dhān* ; Hindi—*Dhān* ; Oriya—*Dhāna*.

PEST—

(a) LEAF-EATING.—

RICE SWARMING CATERPILLAR.—*Spodoptera mauritia*, Boisd.

VERN. NAMES.—*Dhāner Ledā Pokū*—L. Bengal ; *Pātharkūtti*—Cuttack.

NATURE OF DAMAGE.—The caterpillars of this moth feed on the leaves of young paddy plants after they have been transplanted. When few in number, the damage done is inappreciable. But occasionally they come in big swarms and completely destroy the crops by eating up the leaves. After finishing the crop on one field they march in swarms to the next.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Cuttack, Midnapur, Balasore, Bhagalpur and Gya. It attacks paddy after it has been transplanted, *i.e.*, generally in August and September.

FOOD-PLANTS.—Paddy, maize, *marua* and other millets, grasses and low-growing crops.

DESCRIPTION AND LIFE-HISTORY.—It is a medium-sized moth (Figs. 11, 12, Pl. I), of a grey-brown colour, with a black spot and an irregularly waved light line on the fore wing. The hind wing is white. Eggs are laid in masses by the female moths on the leaves of paddy plants, and these are covered with buff-coloured hairs (Fig. 1, Pl. I). Each moth lays from one to several hundred eggs. These hatch within a week and the young caterpillars at once begin to feed on the young leaves. The caterpillar stage covers a period of three to four weeks, during which it grows gradually and changes its skin four or five times. A full-grown caterpillar is about an inch and a half long, of a greyish-yellow colour with reddish and yellowish stripes across its body (Figs. 3—8, Pl. I). When full-fed, it crawls down to the ground and turns into a chrysalid (Fig. 9, Pl. I) in an earthen cell. Moths come out of these chrysalides in ten to twelve days and lay eggs again.

REMEDY.—As the pest generally comes from waste lands, clean cultivation is of prime importance. It is very important to attack these caterpillars at as early a stage as possible, before their numbers have increased. When it has already appeared on a crop, the best procedure would be to pour kerosine over the standing water in the plot at the rate of 3 quarts per acre and to worry the caterpillars constantly by means of

a rope or a long stick. They will then all fall on the kerosined water and die. It has been found that sweeping the crop with a heavy bamboo stick twice or thrice a day was sufficient to disturb the caterpillars so much that they stopped feeding. When the pest is confined to a small area, the field should first be trenched round with vertical-sided trenches and then the caterpillars disturbed. They will begin to move and will ultimately fall into the trenches where they can be killed by thousands. Fields in which caterpillars were seen last should be ploughed up and harrowed.

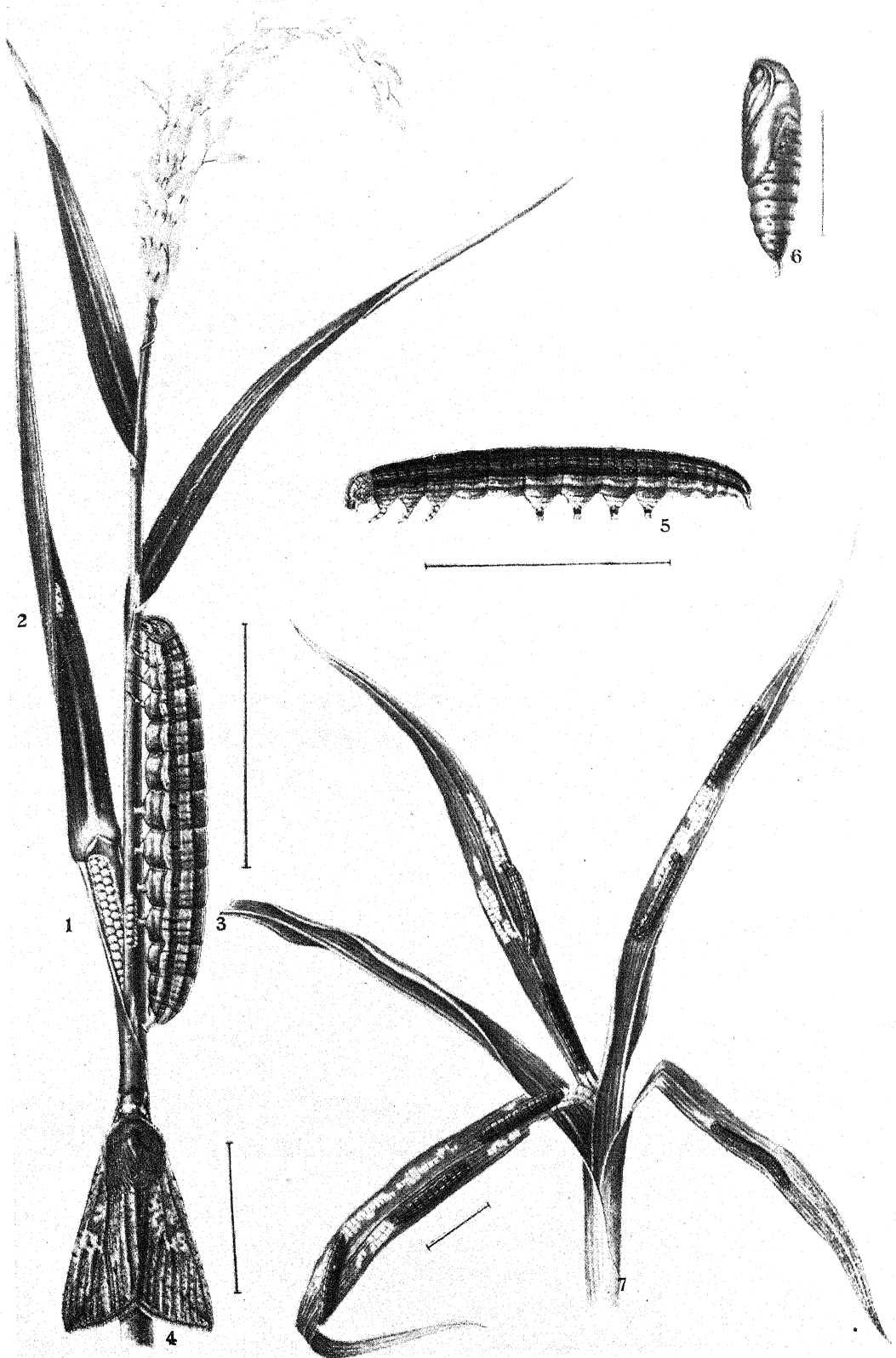
In case of an experimental crop, a good spraying with Lead Chromate or Arseniate (see Appendix No. III) is the best remedy.

The moths can also be caught at night in a patent trap devised by Messrs. Andres Maire, Egypt, which trap is now under experiment in India.

References.—I. I. P., p. 189.

Beng. Q. J. A., Vol. V, No. 3, pp. 153-156.

Swarming Caterpillars on Paddy at Sabour. By H. L. Dutt.



ARMY WORM.

Fig. 1.—Egg-cluster laid inside a leaf-sheath. Fig. 2.—Egg-cluster laid inside the fold of a curled leaf. Fig. 3.—Full-grown caterpillar. Fig. 4.—Moth sitting on plant. Fig. 5.—Same caterpillar of a different colour. Fig. 6.—Pupa. Fig. 7.—Plant with young caterpillars feeding on its leaves. *N.B.*—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

I.—CEREALS.

HOST : A. PADDY.—*Oryza sativa*.

VERN. NAMES.—Beng.—*Dhān* ; Hindi—*Dhān* ; Oriya—*Dhāna*.

PEST—

(a) LEAF-EATING.—

ARMY WORM.—*Cirphis unipuncta*, Haw.

VERN. NAMES.—*Roshā pokā*—Nadia ; *Harni pokā*—Sambalpur ; *Purnaharī*
—Balasore ; *Kajra*—Giridih ; *Ledā pokā*—L. Bengal.

NATURE OF DAMAGE.—It occasionally happens that half-ripe ears of paddy are cut off by some insects at night. The caterpillars of this moth are responsible for the damage. They hide themselves in folds of leaves, cracks in the soil, etc., during the day, crawl up the plants and bite the ears off at night.

LOCALITY AND TIME OF APPEARANCE.—Though this pest has been reported from Balasore only, it may, under favourable circumstances, occur anywhere in the plains of our area where paddy is grown. It generally appears in the advanced stage of the crop's growth, but is also often reported in August—October.

FOOD-PLANTS.—Paddy, juaī, maize, etc.

DESCRIPTION AND LIFE-HISTORY.—It is a medium-sized dusky-coloured moth of nocturnal habits (Fig. 4, Plate II). Eggs are laid by the female moth, generally singly, in folds of leaves or inside leaf sheaths (Figs. 1, 2, Pl. II). One female moth lays as many as 450 eggs. They hatch within a week and the newly hatched young caterpillars feed on the leaves (Fig. 7, Pl. II). For the first few days they hide themselves in folds of leaves during the day, but with growth this habit changes and they come down to the ground to hide in cracks in the soil. For the first few days, the young caterpillars feed on the leaves, but when they grow old they crawl up the plants at night and cut off the ears (Fig. 3, Pl. II). The length of the larval period is about a month, during which a caterpillar changes its skin about five times. When full fed, it comes down to the ground and pupates in the soil (Fig. 6, Pl. II) in an earthen cell. In due course of time, the moths come out and lay eggs on fresh plants.

REMEDY.—They should be worried by means of a long rope or a stick brushing against the attacked crop. Constant disturbance makes them leave the field.

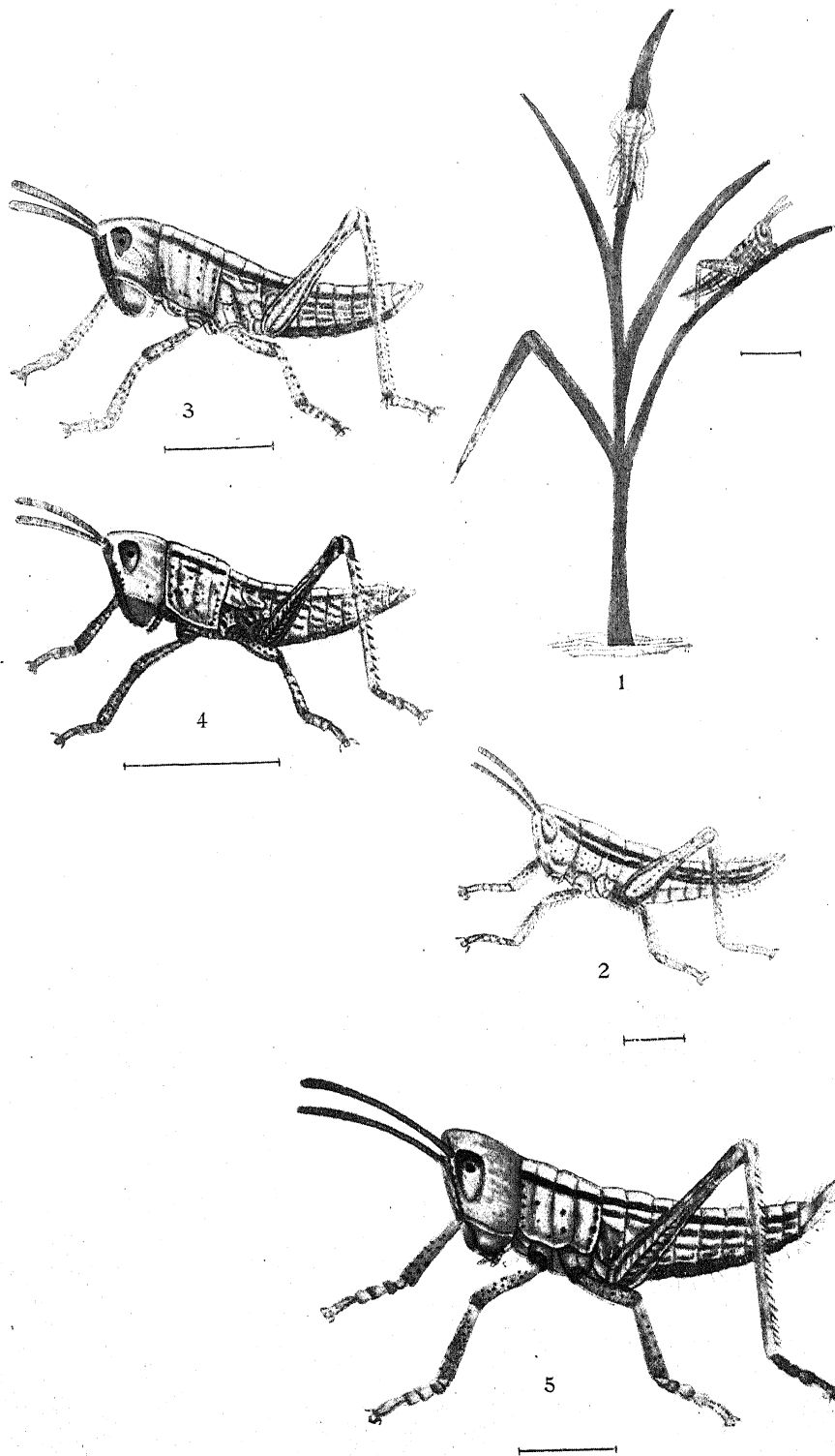
Small heaps of green grass or green leaves, 8—10 feet apart each way, may be scattered all over the field. The caterpillars will leave the plants in the morning and

hide under these heaps. A few hours later, one cooly should go round the area, stir these heaps up, collect the caterpillars and put them in a kerosine tin half filled with water and a little kerosine. A large number of caterpillars can be collected and killed in this way.

The moths can be caught at night in a patent trap, devised by Messrs. Andres Maire, Egypt, which trap is now under experiment in India.

References.—Beng. Q. J. A., Vol. V, No. 3, pp. 153-156.

Swarming Caterpillars on Paddy at Sabour. By H. L. Dutt.



RICE GRASSHOPPER.

Fig. 1.—A rice plant with newly hatched hoppers on it. Fig. 2.—Young grasshopper, first stage. Figs. 3, 4, 5.—Young grasshoppers' second stage, showing variations in colour.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

I.—CEREALS.

HOST : A. PADDY.—*Oryza sativa*.VERN. NAMES.—Beng.—*Dhān* ; Hindi—*Dhān* ; Oriya—*Dhāna*.

PEST—

(a) LEAF-EATING—

RICE GRASSHOPPER.—*Hieroglyphus furcifer*, Serv.VERN. NAMES.—*Dhān Faring*.—Lower Bengal ; *Fatingā*—Behar ; *Jhitikā*—Orissa.

NATURE OF DAMAGE.—Both in its young and adult stages, the rice grasshopper does damage to paddy plants by eating up the leaves. The soft grains are also eaten up by the mature grasshopper, when the ears come up.

LOCALITY AND TIME OF APPEARANCE.—This pest occurs nearly all over our area. It appears as soon as the first heavy rains set in in May or June.

FOOD-PLANTS.—Paddy, sugarcane, grasses and small millets.

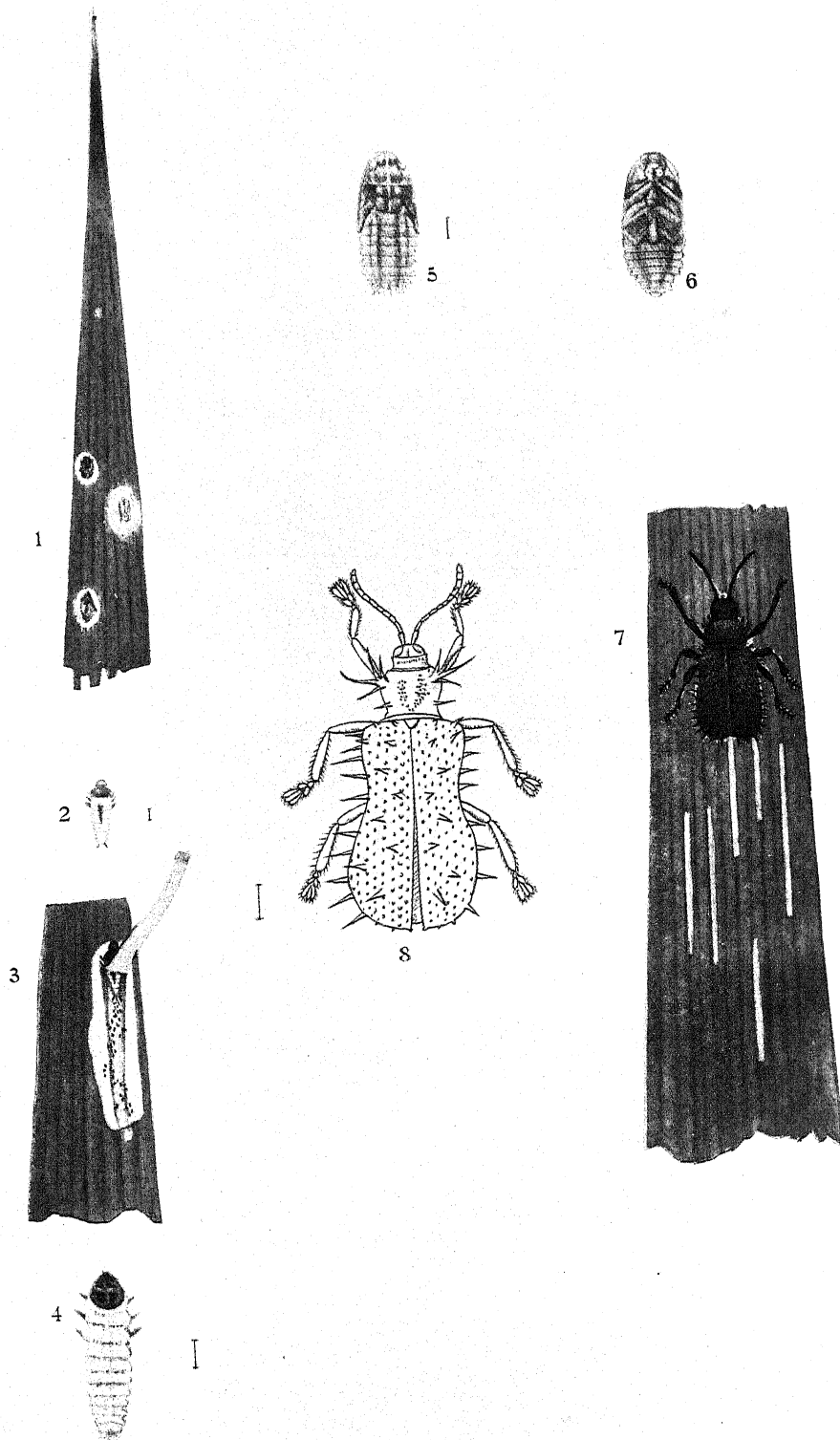
DESCRIPTION AND LIFE-HISTORY.—It is a green or dry-grass-coloured grasshopper, common in paddy fields. Eggs are laid in clusters, embedded in the soil in the fields or embankments, densely packed in a hard cement. Each egg mass is about half an inch long. These are laid in November and they remain in that stage till heavy showers set in in June of the next year. Each female grasshopper lays from 50—60 eggs. When the eggs hatch in June, small active wingless grasshoppers (Figs. 2—5, Pl. III) come out and feed on the leaves of growing paddy plants. They grow gradually, and in about eight to ten weeks become full-grown. During this period they change their skins five times and the wings develop further at each change of skin. A young insect looks very much like an adult one, except that it is smaller in size and is not provided with well-developed wings. Mating takes place either late in September or early in October, after which the female lays eggs in the soil about an inch and a half below the surface. As has been stated above, the eggs remain in this condition through the winter and hatch in the next rainy season. The pest has only one brood in the year.

REMEDY.—Destroying the egg clusters is the easiest method of checking the pest, but it is not possible to locate them in the field. However, in areas where the pest occurs regularly every year, it is best to plough up and beam the fields in April and May. This will expose the eggs to the dry heat and kill them.

Bagging is the best remedy. See Appendix No. I.

References.—I. I. P., pp. 119-21.

Mysore Department of Agriculture, Bulletin No. I of 1911, by L. Coleman.



RICE HISPA.

Fig. 1.—Eggs inside leaf. Fig. 2.—Young grub magnified. Fig. 3.—Grub inside leaf. Fig. 4.—Full-grown grub magnified. Fig. 5.—Pupa as seen from above. Fig. 6.—Pupa as seen from below. Fig. 7.—Beetle on a leaf. Fig. 8.—Beetle in outline showing the spines. N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

I.—CEREALS.

HOST : A. PADDY.—*Oryza sativa*.

VERN. NAMES.—Beng.—*Dhān* ; Hindi—*Dhān* ; Oriya—*Dhāna*.

PEST.—

(a) LEAF-EATING—

RICE HISPA.—*Hispa anescens*, Baly.

VERN. NAMES.—*Pāntri pokū*—24-Pergannas ; *Shānkū*—Khulna ; *Shānki*—Howrah & 24-Pergannas ; *Pāruli*—Khulna ; *Morich pokū*—Bankura ; *Mādhvā* & *Kol*—Darbhanga ; *Birhiā*—Balasore.

NATURE OF DAMAGE.—The grubs of this beetle mine in paddy leaves and feed on the tissues between the two epidermal layers and the adult beetles feed on the leaves, so it is injurious in its young and adult stages alike.

LOCALITY AND TIME OF APPEARANCE.—This pest has been reported from the following places :—Howrah, Chinsurah, Burdwan, 24-Pergannas, Jessore, Nadia, Cuttack and Patna. It generally attacks paddy in the seed bed or just after it has been transplanted.

FOOD-PLANTS.—Paddy, grasses.

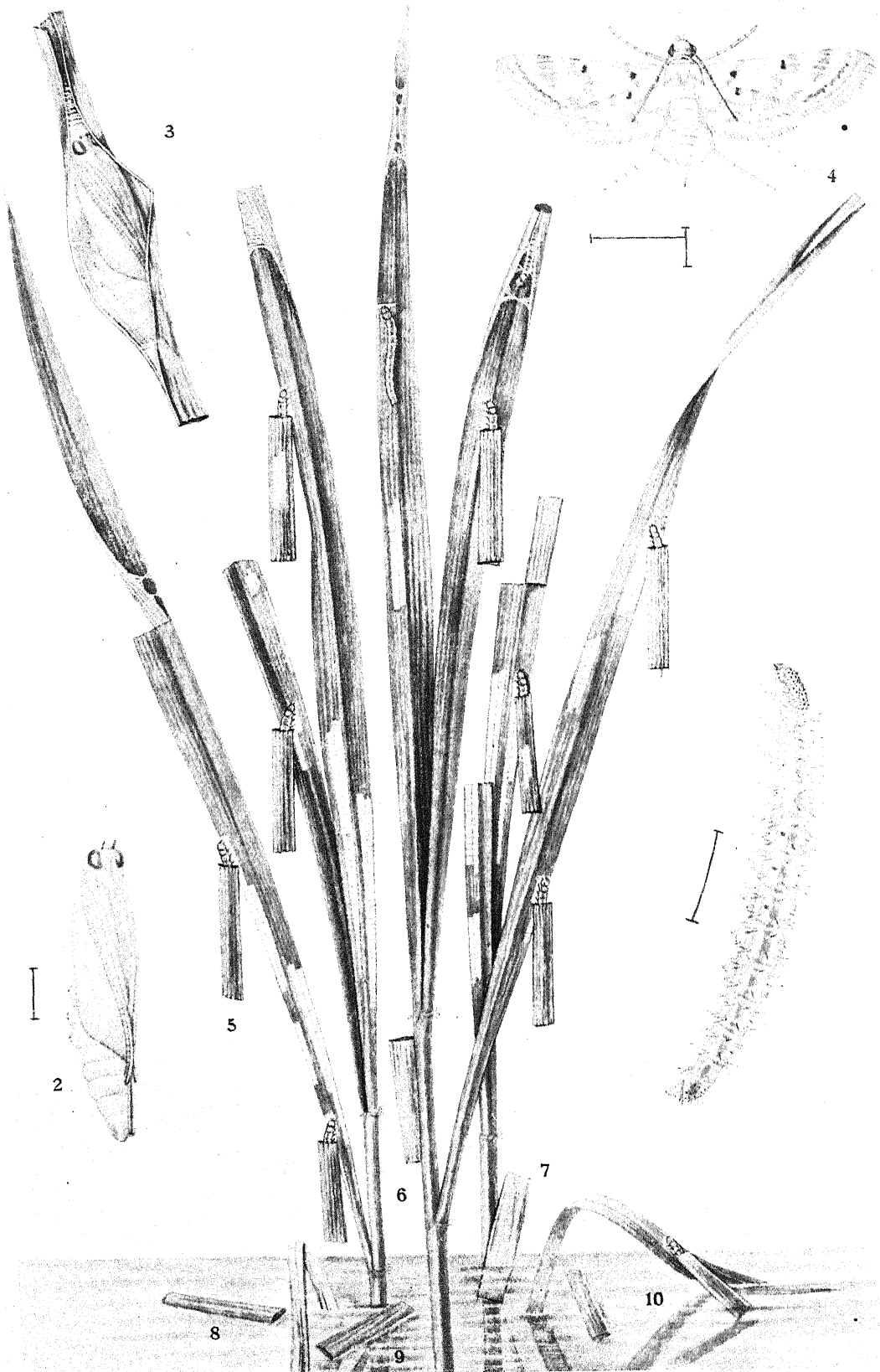
DESCRIPTION AND LIFE-HISTORY.—It is a small blue-black beetle covered with spines all over the body (Fig. 7, Plate IV). The female beetle lays eggs (Fig. 1, Pl. IV) singly on paddy leaves not far from the tip. Each egg is inserted into the tissues of the leaf between the two epidermal layers. The presence of an egg in a leaf is detected by a white spot round it. In about five days the egg hatches and the small whitish or yellowish flattened grub (Fig. 2, Pl. IV) remains inside the leaf and feeds on the tissues there (Fig. 3, Pl. IV). As the leaf tissue is used up, a big yellow blotch is formed round the grub. If one such leaf be held against the light, the insect inside may be seen. The grub never comes out of its mine in this stage. When full-fed it transforms into a brown flattened pupa (Figs. 5, 6, Pl. IV) inside the leaf from which the mature beetle comes out in about four days. The adults feed on the leaves of the paddy plants and cause further damage.

REMEDY.—The normal food-plants of this insect are wild grasses, so that if the beetles are attacked and destroyed on them, the chances of a later attack on paddy will be minimised. Since the pest thrives well under moist conditions, it generally attacks submerged paddy rather than that on higher land. Advantage is taken of this in several districts by letting out the water from infested fields, which makes the crop

less attractive to the insect. Smoking also is practised in some places, as it drives the pest away and so prevents the beetles from laying their eggs. The best remedy is to bag the insects with an insect bag (see Appendix No. I). This should be done as soon as the insects first appear, in order to prevent them from laying their eggs on the plants. Once the eggs are laid in the leaf very little can be done except by picking and burning the yellow spotted leaves, until the mature beetles again emerge.

Harder varieties of rice should be grown where the pest is very prevalent.

References.—I. I. P., pp 114-115.



RICE CASE WORM.

Fig. 1.—The worm out of its case. Fig. 2.—The chrysalis out of its case. Fig. 3.—The chrysalis in its case. Fig. 4.—The moth. Figs. 5, 6, 7, 8, 9 & 10.—The worms in their cases feeding on the paddy plant.

N.B.—In case where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

I.—CEREALS.

HOST : A. PADDY.—*Oryza sativa*.VERN. NAMES.—Beng.—*Dhān* ; Hindi—*Dhān* ; Oriya—*Dhāna*.

PEST—

(b) LEAF-ROLLING—

RICE CASE WORM.—*Nymphula depunctalis*, Guen.VERN. NAMES.—*Bānki*—Ranchi ; *Nalipokā*, Lowray—Bankura ; *Kitipokā*—Nadia ; *Bakki*—Cuttack.

NATURE OF DAMAGE.—It is sometimes seen that a large number of green tubes about 1—1½ inches long, made of paddy leaves, are floating on the surface of the water in the paddy fields. On examination each tube will be found to have a caterpillar inside it. Bits of paddy leaves are cut out by the caterpillars of this moth, and with the help of these they float on the water and move from plant to plant. These caterpillars crawl up the plants in the field and feed on the leaves. When one tube gets dried up, another is made by the caterpillar.

LOCALITY AND TIME OF APPEARANCE—It has been reported from Ranchi, Cuttack and Nadia. It appears in submerged Aman paddy fields either in September or October.

FOOD-PLANTS.—Paddy.

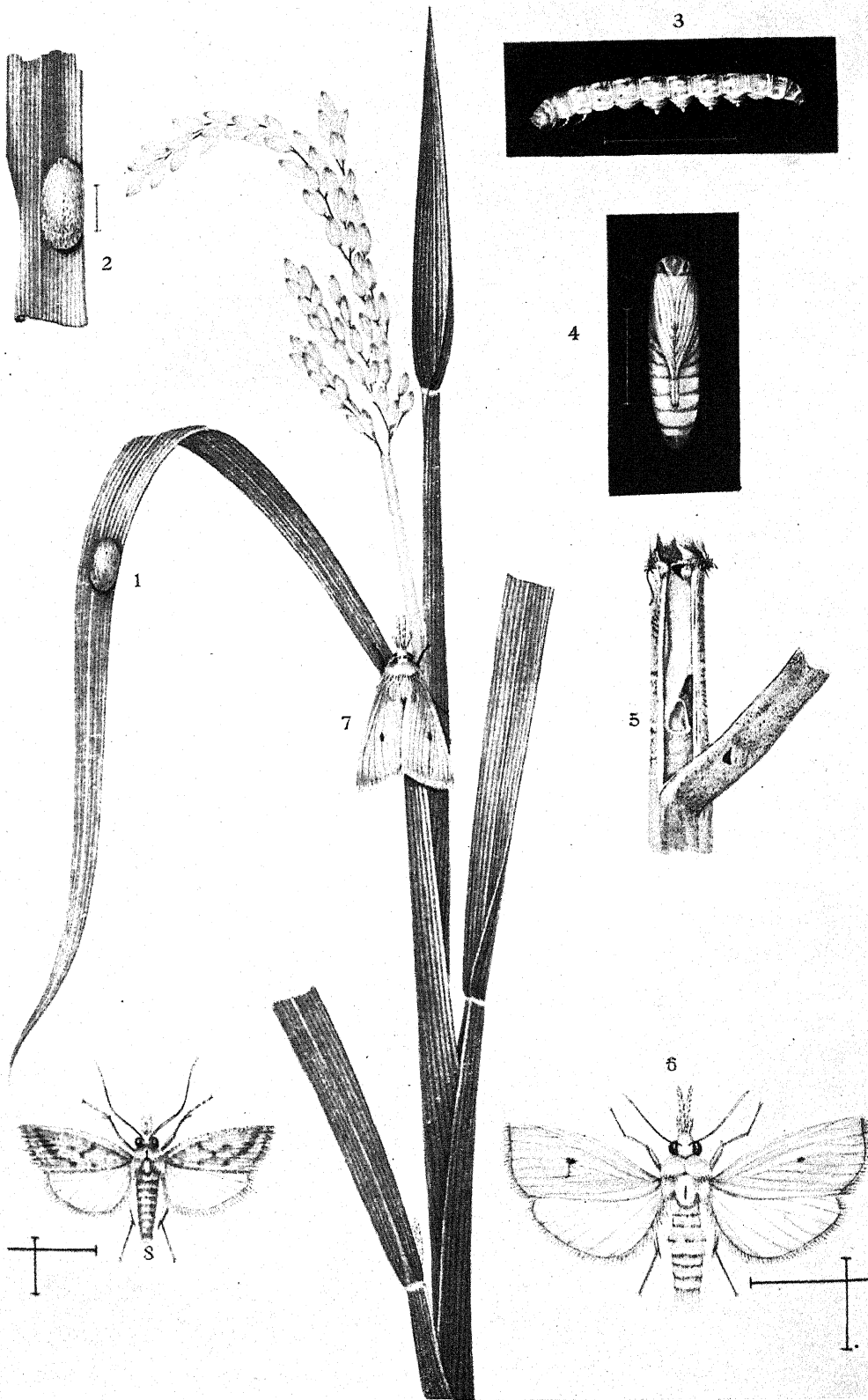
DESCRIPTION AND LIFE-HISTORY:—The female moth (Fig. 4, Plate V) lays eggs singly on the tips of paddy leaves. These hatch in a few days, and the young caterpillar cuts across a leaf which it makes into a tube (about one inch long) and fastens round its body (Figs. 5—10, Plate V). When a caterpillar crawls up a paddy plant to feed on its leaves, it carries the tube along with it, keeping only its head and a small portion of the body outside, in order to facilitate the movements of the legs (Figs. 5—10 in Plate). It often drops suddenly on the surface of the water, and paddles along till it reaches another plant. Sometimes it cuts off a plant just at the surface of the water. In this way it passes about 20 days, after which it pupates inside the tube (Fig. 3, Plate V), first securing it to a plant with silk. A full-fed caterpillar measures about an inch, and is of a greenish colour and provided with hair-like processes on the whole body (Fig. 1, Plate V). Small white moths with yellow and dark specks on the wings come out of the pupæ to lay eggs again (Fig. 4, Plate V). From what has been said above it is evident that the pest will never appear in a paddy field which has no standing water in it.

LEAFLET 5.

REMEDY.—(1) Dragging a big net, with fine meshes across the field with the lower end running below the surface of water, has been found successful. The caterpillars are collected on one side of the field where they can be easily destroyed.

(2) Pour kerosine oil over the standing water, at the rate of 4 quarts per acre, care being taken to distribute it uniformly over the whole surface. The caterpillars will all die on coming in contact with the kerosine and those on the plants are to be brushed by a bamboo or rope into the water.

(3) Letting out water from the field will check the pest, but this can be done only in those places where water can be supplied again.



RICE STEM BORER.

Figs. 1, 2.—Egg-clusters. Fig. 3.—Caterpillar magnified. Fig. 4.—Pupa magnified. Fig. 5.—Cocoon inside a stem. Figs. 6, 7, 8.—Moths.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

I.—CEREALS.

HOST : A. PADDY.—*Oryza sativa*.VERN. NAMES.—Beng.—*Dhān* ; Hindi—*Dhān* ; Oriya—*Dhāna*.

PEST—

(c) STEM-BORING—

RICE STEM-BORER.—*Schoenobius bipunctifer*, Wlk.VERN. NAMES.—*Gondālia*, *Goricāta*, *Gorinda*, *Bakpokiā*—Cuttack ; *Muliā*, *Totāpokā*—Midnapur ; *Chattar*—Palamau ; *Hāthiāpokā*—Nadia ; *Mājrāpokā*—L. Bengal ; *Garbsukhu*—Gya.

NATURE OF DAMAGE.—The caterpillars of this moth bore into paddy stems, causing them to bear only empty ears. When a young plant is attacked, no ear is produced at all. An affected plant can at once be recognised by the whitish appearance of the shoot or ears.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Bankipur and Cuttack. It generally attacks paddy in October when the plants are beginning to flower.

FOOD-PLANT.—Paddy.

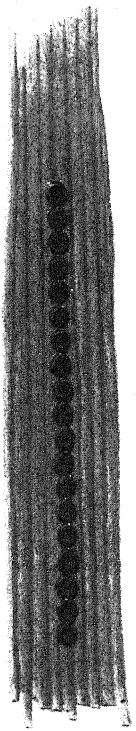
DESCRIPTION AND LIFE-HISTORY.—It is a small moth of a straw-yellow colour, the forewings having one black dot on each (Figs. 6, 7, 8, Plate VI). The female moth lays eggs on paddy leaves in clusters, which are covered over with buff-coloured hairs. (Figs. 1, 2, Plate VI). The eggs hatch in a week and a young caterpillar in coming out, feeds first on the epidermis of a leaf, after which it bores into the stem either near a leaf stalk or still further down. It remains inside the stem for about a month, and feeds on its tissues. A full-grown caterpillar measures about three-fourths of an inch, is slender, soft-bodied and of a dirty white colour (Fig. 3, Plate VI). When full-fed, it stops feeding and webs up a silken case inside the tunnel and pupates in it. This case has an opening on one side with a lid hanging over it (Fig. 5, Plate VI). After remaining as pupa (Fig. 4, Plate VI) for about a week in the case, it comes out as a moth through this hinged door, and lays eggs. The pest goes on breeding in paddy till November. From November till June the caterpillars remain as such in the paddy stubbles left in the field after harvest. The damage done to a plant can at once be noticed by the white shoots and ears.

REMEDY.—Withering affected plants should at once be uprooted and burnt or buried in the ground, or otherwise the moths will come out of them and lay their eggs. Early action will check the pest completely.

LEAFLET 6.

The moth is attracted by light, so that the lighting of small bonfires in an affected area at night will attract and kill the moths and further egg-laying will be prevented.

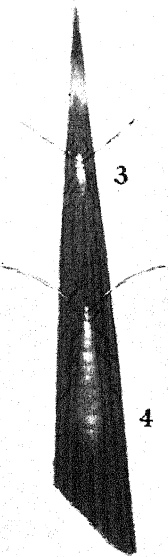
As soon after harvest as possible, the stubbles in the fields should be destroyed by ploughing. The resting caterpillars inside them are thus killed and prevented from coming out as moths at the beginning of the next season. Flooding the fields after harvest, where possible, is also a good practice as it kills all the caterpillars in the stubbles.



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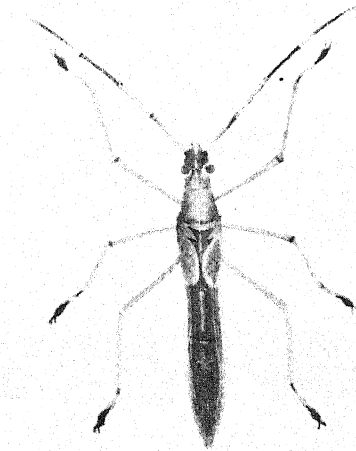


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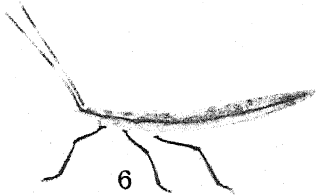


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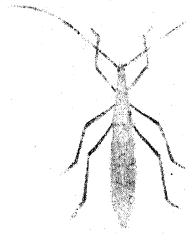
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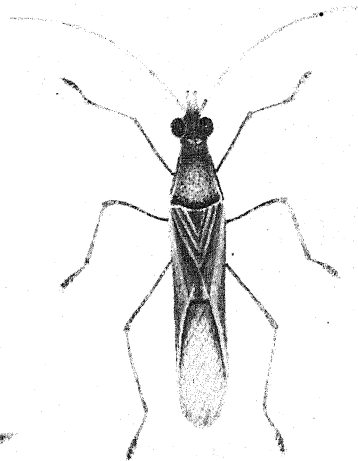
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5



8

RICE BUG.

Fig. 1.—A cluster of eggs on a leaf. Fig. 2.—Egg from side. Figs. 3 to 7.—Nymphs in different stages of growth. Fig. 8.—An adult bug.

I.—CEREALS.

HOST : A. PADDY.—*Oryza sativa*.

VERN. NAMES.—Beng.—*Dhān* ; Hindi—*Dhān* ; Oriya—*Dhāna*.

PEST—

(d) GRAIN-SUCKING—

RICE BUG.—*Leptocorisa varicornis*, F.

VERN. NAMES.—*Bhomā*—Midnapur, Bankura; *Gandhi*—Birbhum, Murshidabad and Behar in general ; *Maluā*—Orissa *Makhi*—Ranchi.

NATURE OF DAMAGE.—This insect is a bug with sucking mouthparts, *i.e.*, there is a syphon-like arrangement in its mouth with which it sucks liquid food. When the paddy crop begins to flower, these bugs come out in large numbers from the jungles and suck out the milk from the newly forming grains. The sucked out empty ears appear white and when the pest is abundant, a whole crop may turn colour in this way.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Birbhum, Midnapur, Ranchi, Bankura, Cuttack and Bhagalpur. It is common in all the paddy-growing areas in Bengal. It is found in grasses throughout the year but appears in the paddy fields when the grains are forming.

FOOD-PLANTS.—Rice, small millets, grasses.

DESCRIPTION AND LIFE-HISTORY. —It is a slender green or light brown bug (Fig. 8, Plate VII), a little over half an inch in length, found flying in paddy fields when the ears form. It emits a strong unpleasant smell on account of which it is known as "Gandhi" in some parts of Bengal. The female bug lays eggs in rows (Fig. 1, Plate VII) arranged symmetrically in one or two or three lines on the leaves. The eggs are dark-coloured, oval in outline and flattened on the top (Fig. 2, Plate VII). They hatch within a week, and little bugs with slender green bodies and long legs and feelers come out (Figs. 3—7, Plate VII). At first these young ones do not possess any wings, but they develop gradually with the growth of the insect. The wings attain their full size in about 20 days and it is only then that they can fly from field to field. The young insects have the same kind of sucking mouthparts as the adults. They all cluster together on ripening ears and suck out the milky juice. They increase and multiply only when there is plenty of food, *i.e.*, from July to November. During the winter they do not breed and just manage to tide over the period as adults living on grasses till the next season comes.

ENEMIES —A steel blue beetle about an inch long, with six white spots on the wing covers is common in paddy fields. This beetle feeds greedily on rice bugs ; and so should never be destroyed. It is known as *Dhamsa-poka* in Lower Bengal.

REMEDIES.—Bagging is the most efficient method of fighting this pest (see App. No. I). The bag should be soaked in strong crude oil emulsion (1 pint in 2 gallons of water) and run through the field brushing the upper half of the crop. The bugs are thus caught in them and can be destroyed by twisting up the bag at the end of each run. This method requires co-operation among the cultivators of adjoining fields. It is no good trying it in a small area when the neighbouring fields are teeming with the pest, as they are sure to come over to the treated area again.

If small bonfires are lighted in affected paddy fields at night, many winged adults will be attracted and killed.

References.—Mem. D. Ag. I. (Ento. Series), Vol. II, No. I. Rice Bug by H. M. Lefroy.
I. I. P., pp. 116-118.

I.—CEREALS.

HOST : A. PADDY.—*Oryza sativa*.VERN. NAMES.—BENG.—*Dhān* ; Hindi—*Dhān* , Oriya—*Dhāna*.

PEST—

(e) LEAF & STEM-SUCKING—

RICE LEAF HOPPER—*Liburnia*, Sp.VERN. NAMES.—*Madhapokā*, *Dholsunro*, Nadia : *Dhoreli*—Cuttack, Midnapur, Ranchi, Puri, Balasore ; *Kharmut*—Bankipur

NATURE OF DAMAGE.—This insect is a bug with sucking mouthparts, *i.e.*, there is a syphon-like arrangement in its mouth with which it sucks liquid food. Both the adult and young insects do considerable damage to Aus and Aman paddy by sucking the sap out of the tender leaves.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Nadia, Burdwan, Hooghly, Ranchi, Midnapur, Cuttack, Puri, Balasore. It generally appears during August when the plants are about a foot high and in case of Aman paddy about two weeks after transplantation.

FOOD-PLANT.—Paddy and grass.

DESCRIPTION AND LIFE-HISTORY.—It is a very small greyish white insect found flying and hopping from leaf to leaf in an affected paddy field. Eggs are laid by the female insects probably in the tissues of the leaves. The young ones immediately after hatching do not possess any wings, but these develop with the growth of the insect. They are milky-white in colour but dark bands appear with change of skin. A young bug becomes an adult without passing through a pupal stage. The adult insect has two pairs of transparent wings, roofed over it, of which the first extend much beyond the end of the body. On being disturbed, it jumps about with great activity from leaf to leaf, and when it drops on water, it jumps on till it reaches another leaf. An attacked crop has a stunted yellow appearance, and in many cases the surface soil below the crop gets covered with a deposit, due to a sweet liquid exuded by the insect from the hind end of its body.

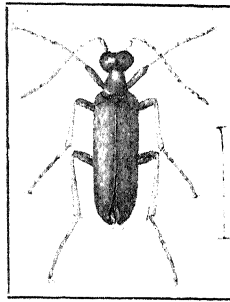
REMEDY.—In Aman land, where there is standing water in the field, an application of kerosine is the most effective remedy. Three quarts of it are to be applied per acre ; it should be sprayed on the standing water in different places, so that it may be distributed uniformly over the whole surface. Immediately after this a long bamboo should

LEAFLET 8.

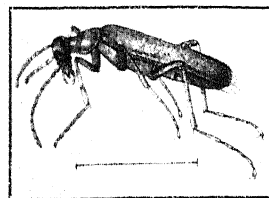
be drawn across the field several times by means of ropes at the two ends, brushing the plants vigorously so as to make all the insects fall into the water. The insects will all be killed on coming in contact with the kerosine film on the surface of the water below.

On Aus land bagging (see Appendix No. I) is the best method.

PLATE VIIa.



Brown Blister Beetle.



Brown Blister Beetle.

I.—CEREALS.

HOST : A. PADDY.—*Oryza sativa*.

VERN. NAMES.—Beng.—*Dhān* ; Hindi—*Dhān* ; Oriya—*Dhāna*.

PEST—

(f) FLOWER-EATING—

BLISTER BEETLES.—*Cantharis acteon*, Cast., *Cantharis rouxi*, Cast., *Mylabris* *side*, F.

NATURE OF DAMAGE.—The adult beetles feed on the flowers of plants.

LOCALITY AND TIME OF APPEARANCE.—These beetles are found all over our area. They generally appear in large numbers and settle in gardens destroying the flowers of pumpkins, cucumbers, etc. The green and brown varieties damage paddy, sorghum, *kulthi*, etc., by eating the flowers. They generally appear in August, September and October.

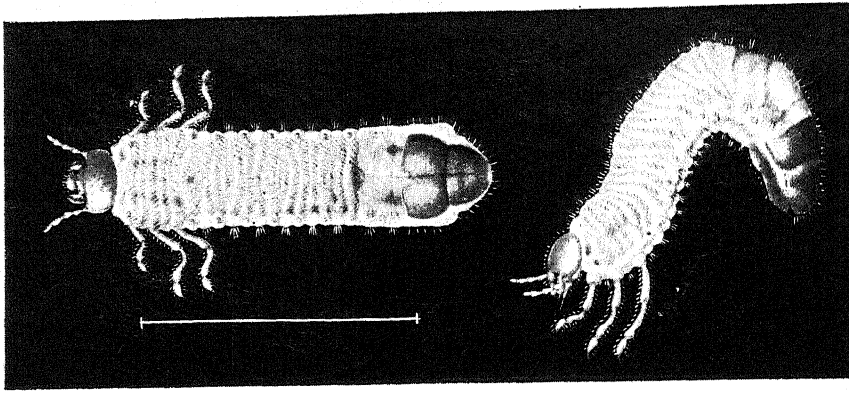
FOOD-PLANTS.—Flowers of juar, maize, paddy, small millets, Malvaceous, Cucurbitaceous and Leguminous crops and vegetables.

DESCRIPTION AND LIFE-HISTORY.—These are medium-sized beetles, about an inch long and of a bright colour. One is black with bright yellow bands, another is bright green, and still another of a dull brown or steel blue colour. They are distinguished by their soft bodies and a distinct neck between the head and the thorax. When handled, they exude an acrid yellow liquid from the joints of the legs. They possess good powers of flight. Their life-histories have not been fully worked out. Eggs are laid in the ground and the young active grubs run about the surface.

REMEDY.—Bagging is very effective on paddy (see Appendix No. I). If small fires are lighted in the field when the air is still and the smoke allowed to hang on the crop, it drives them away.

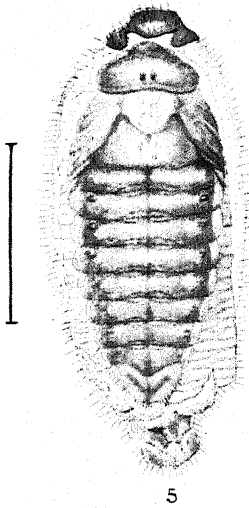
In gardens they should be collected by hand nets and destroyed.

References.—I. I. P., pp. 205-207.

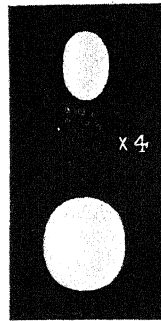


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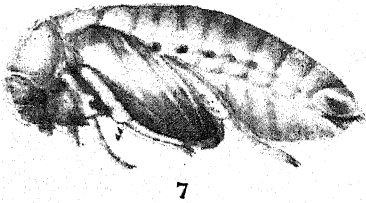


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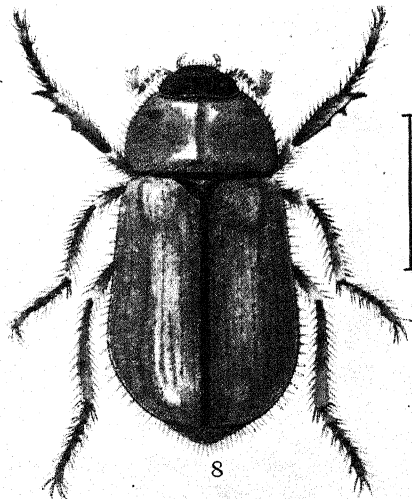
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7



8

THE COCKCHAFER.

Figs. 1, 2—Eggs. Fig. 3—Larva (seen from above). Fig. 4—Larva (seen from side). Fig. 5—Pupa encased in larval cast-off skin (seen from above). Fig. 6—Pupa (seen from below). Fig. 7—Pupa (seen from side). Fig. 8—Beetle (seen from above).

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

I.—CEREALS.

HOST : A. PADDY.—*Oryza sativa*.

VERN. NAMES.—Beng.—*Dhān* ; Hindi—*Dhān* ; Oriya—*Dhāna*.

PEST—

(g) ROOT-EATING—

COCKCHAFER.—*Anomala varians*, Oliv.

VERN. NAMES.—*Gobra pokā*, *Korā pokā*.—Lower Bengal ; *Gajrā*—Jessore.

NATURE OF DAMAGE.—Occasionally the young grubs of this beetle kill paddy plants by cutting their roots. Young plants suddenly wither and on examination, white shiny grubs with yellow heads are found feeding on the roots a few inches under the soil near the base of the plant. It is evident from the habit of the insect that the attack must occur on land which has no standing water on it.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Jessore and Muzaffarpur. At Jessore the attack was rather serious on one block, the attacked young plants drying up all over the area. The damage may be expected from June to August.

FOOD-PLANTS.—Grubs—Roots of grasses and paddy.

Adults—Leaves and soft grains of millets, etc.

DESCRIPTION AND LIFE-HISTORY.—It is a light brown beetle, a little less than an inch in length (Fig. 8, Plate VIII), of nocturnal habits. During the day it remains concealed in some sheltered position and at dusk comes out and flies about with a buzzing noise. It is slightly attracted by light. In April and May the female beetles lay eggs singly in the soil. These hatch within a week and curved bodied, dirty grey grubs come out (Figs. 3, 4, Plate VIII), which live in the soil and move about in it by driving their heads through and dragging their soft bodies behind. In this stage their main food is the roots of plants. In September or October they go down deep into the soil and rest there as grubs during the winter. In April or May next year they transform into pupæ (Figs. 5—7, Plate VIII) and in about 10 days come out as adult beetles.

REMEDY.—After the first few showers of rain in April and May, the adult beetles may be attracted and burnt by lighting small bonfires in the fields for some consecutive nights. This will prevent them from laying their eggs.

When an attack is first noticed in the field, it is always advisable to turn up the soil under the withering plants, collect the grubs and destroy them.

Since these beetles breed also in cowdung, farm-yard manure should be examined before being applied to the field. Grubs should not be allowed to remain in the manure to be applied.

References—Mem. D. Ag. I., Vol. II, No. 8 (Ento. Series). Life-Histories of Indian Insects, Coleoptera 1. by H. M. Lefroy.

I.—CEREALS.

HOST : A PADDY.—*Oryza sativa*.

VERN. NAMES.—Beng.—*Dhān* ; Behari—*Dhan* ; Oriya—*Dhāna*.

PEST—

DISEASE.—A disease of uncertain origin.

VERN.—*Dakhina* in Champaran ; *Dakhinabira* in Gya ; *Chatra* in Saran and Shahabad ; *Ukra* in Muzaffarpur ; *Bubhuni* in Darbhanga ; *Kadamara* in Chinsurah ; and *Bhangiputti* in Sambalpur.

DESCRIPTION.—An obscure but widespread disease of paddy reported from different parts of the Province under different local names of which *Chatra* may possibly be a different disease from the rest. It causes much damage to the paddy crop and considerable alarm amongst cultivators. It may appear at any time from the transplantation of the crop to the development of the ears. As a result of the attack whole fields or very large portions of them become suddenly withered, the leaves and stalks of the plants turn brown and brittle, and, if ears have formed, the husks contain no grains. Careful examination of various parts of the plants occasionally shows the presence of a fungus which has by some been associated with the cause of the disease ; but it has been doubted by others if such is actually the case. Possibly the disease is due to waterlogging and imperfect aeration of the soil or to the production of poisonous substances in the soil by the decomposition of organic matter, an assumption which is borne out by the fact that the disease is found more common in low-lying waterlogged places than elsewhere.

REMEDY.—The disease appears to be quite amenable to the treatment practised in some parts of Bengal, namely, either (i) by draining the soil and allowing it to dry and then reflooding it, or better (ii) by applying Sodium Sulphate (*Khari Nimak*) at the rate of 15 to 20 seers per acre while the water is still standing in the field. Under the second treatment it is said that not only the plants revive but grow more vigorously than untreated healthy plants.



FALSE SMUT OF RICE—(*Ustilagoidea Oryzæ*.)
Showing the healthy and the swollen dark coloured diseased grains.

I—CEREALS.

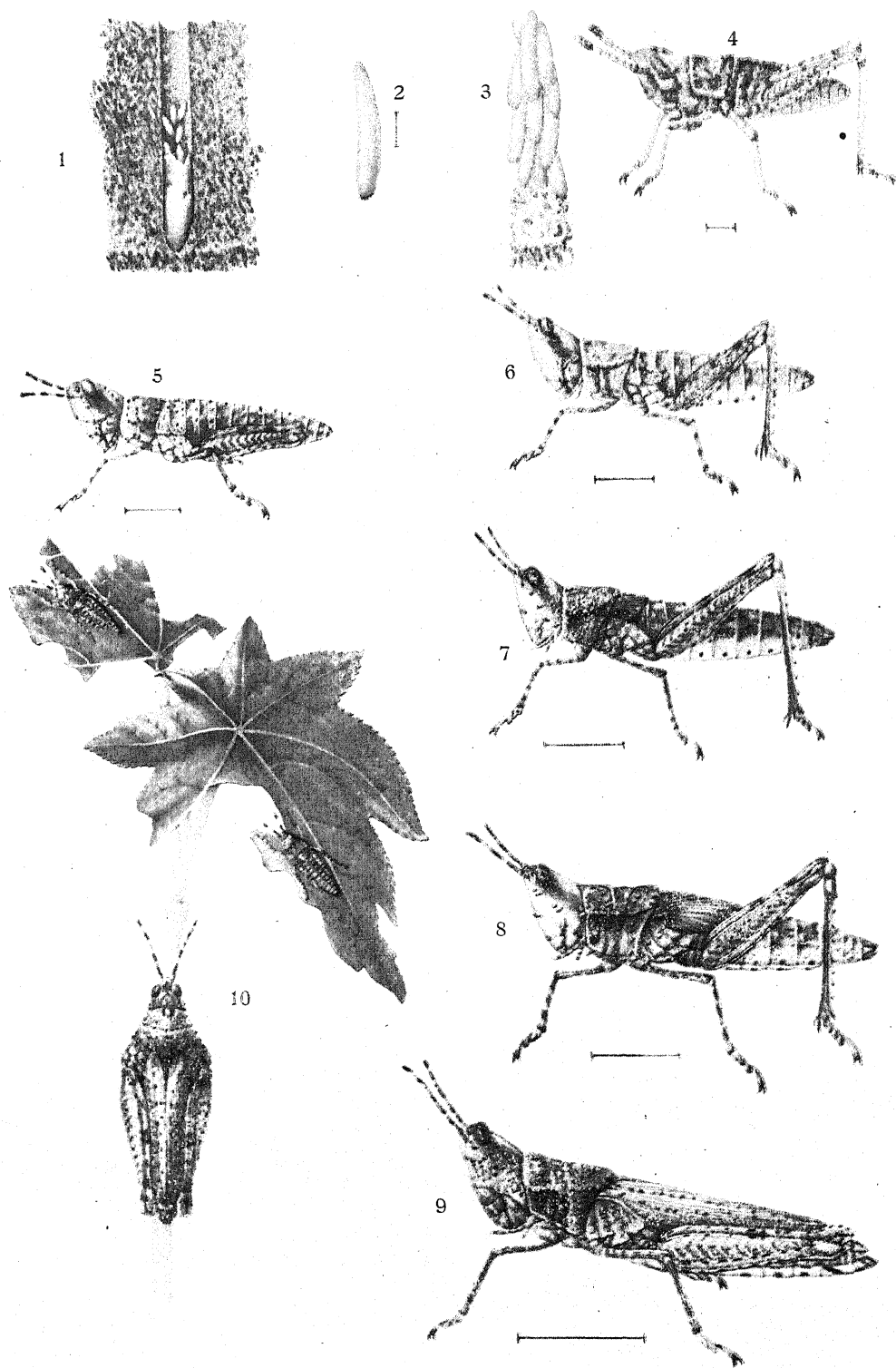
HOST: A. PADDY.—*Oryza sativa*.VERN. NAMES.—Beng.—*Dhān*; Behari—*Dhān*, Oriya—*Dhāna*.

PEST—

FUNGUS.—*False smut, Ustilaginoidea Oryzae*, Pat.VERN. NAME.—*Dhaneragu*—Bengal.

DESCRIPTION.—Although it is not a very uncommon disease of paddy, yet it is not so far known to cause much damage to the crop. The fungus attacks only individual grains in the ear, the glumes remaining free. The attacked grains appear much swollen (*vide* Plate IX) owing to the formation of a compact mass of the fungus threads which appears dirty green in colour and somewhat velvety to the touch. On the surface of this body are produced the spores of the fungus. The fungus resembles the smut in appearance, but does not belong to the same group, hence it is called “false” smut.

REMEDY.—No treatment has been necessary so far, as the damage done is slight.



SURFACE GRASSHOPPER.

Fig. 1.—Egg cluster in soil. Fig. 2.—An egg magnified. Fig. 3.—An egg cluster with cover removed, shown magnified. Fig. 4.—An young grasshopper. Figs. 5—9.—Appearance of the grasshopper after each successive casting of the skin. Fig. 10.—An adult grasshopper.

N.B.—In cases where the insects have been drawn larger than life size the hair lines beside them indicate their natural size.

I.—CEREALS.

HOST : B. WHEAT.—*Triticum vulgare*.

VERN. NAMES.—Beng.—*Gam*, *Godhum* ; Hindi—*Gelum* ; Oriya—*Gahamā*.

PEST—

(a) LEAF-EATING—

SURFACE GRASSHOPPER.—*Chrotogonus trachypterus*, Bl.

VERN. NAMES.—*Fatingā* and *Tiddi*—Behar ; *Māt Faring*—L. Bengal ; *Gadhiā*—Bhagalpur, Monghyr.

NATURE OF DAMAGE.—This grasshopper is injurious to wheat seedlings both in its young and adult stages. It cuts off the plants close to the surface of the ground and feeds on the young leaves. Sometimes its attack is so serious that whole fields have to be resown.

LOCALITY AND TIME OF APPEARANCE.—It probably occurs all over our area and is found throughout the year. Its attack is more general in *rabi* sowings but occurs also in the *khariḥ* season, specially when heavy rain has not checked the insects.

FOOD-PLANTS.—It is a major pest, responsible for much loss in germinating crops. Young plants of wheat, sugarcane, cotton, opium, tobacco, millets, potato, castor, etc., are attacked by it.

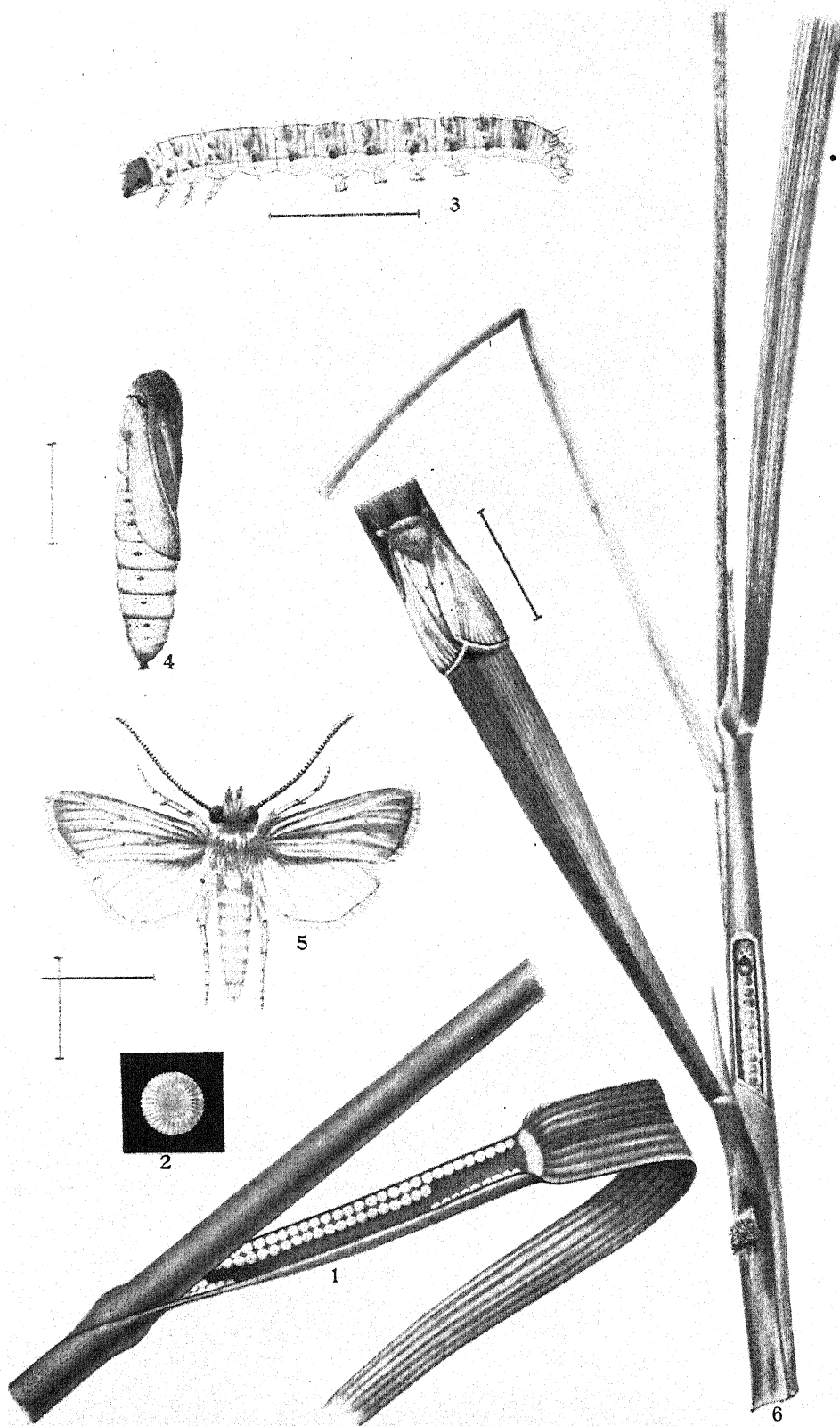
DESCRIPTION AND LIFE-HISTORY.—These grasshoppers are of a dull brown colour resembling that of a ploughed field (Fig. 10, Plate X). Their colour blends so well with the general colour of the soil that it is difficult to find out the insect when resting on ploughed land. A female grasshopper lays eggs in clusters in pockets in the soil made by thrusting the hind end of her body into it (Figs. 1, 2, 3, Pl. X). When the eggs hatch, the young wingless grasshoppers come to the surface and feed on the leaves of the young plants just as their parents do. They resemble the adults much in appearance except that they are smaller and wingless, the wings growing gradually with the growth of the insect (Figs. 4—9, Pl. X). The adult grasshoppers do not fly, but jump from one place to another in spite of the fact that they possess two pairs of well developed wings.

REMEDY.—Bagging (see Appendix No. I) is the most effective method of checking this pest.

Flooding the field where possible is also very useful.

The damage to a germinating crop can be minimised by making a light sowing of some quick-growing crop like mustard, which will attract the insects from the young wheat or opium and which can be afterwards weeded out.

References.—I. I. P., pp. 220-224.



WHEAT STEM-BORER.

Fig. 1.—Eggs laid inside leaf-sheath. Fig. 2.—A single egg magnified. Fig. 3.—Caterpillar magnified. Fig. 4.—Pupa magnified. Fig. 5.—Moth with wings spread. Fig. 6.—An affected plant showing caterpillar in the stem and moth sitting on leaf.

N. B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

I.—CEREALS.

HOST : B. WHEAT.—*Triticum vulgare*.

VERN. NAMES.—Beng—*Gam*, *Godhūn* ; Hindi—*Gehum* ; Oriya—*Gahamā*.

PEST—

(b) STEM-BORING—

PINK BORER.—*Scsania uniformis*, Ddgn.

VERN. NAMES.—*Majra*—Lower Bengal ; *Goricatā*, *Garindā*, *Gondaliā*—Cuttack ; *Pihikā*—Shahabad ; *Garbsukhu*—Gya.

NATURE OF DAMAGE.—The caterpillars of this moth bore into the stems of wheat plants. As they feed on the tissues inside, the plants wither and produce no ears. If the stem of an affected plant is opened up, the caterpillar will be seen inside. When a wheat plant is attacked by white-ants, the whole plant dries up, but when attacked by a borer, only the particular shoot with the caterpillar in it dies.

LOCALITY AND TIME OF APPEARANCE.—This pest is probably general all over the plains of Bengal. In Behar, the main attack on wheat occurs about the middle of January.

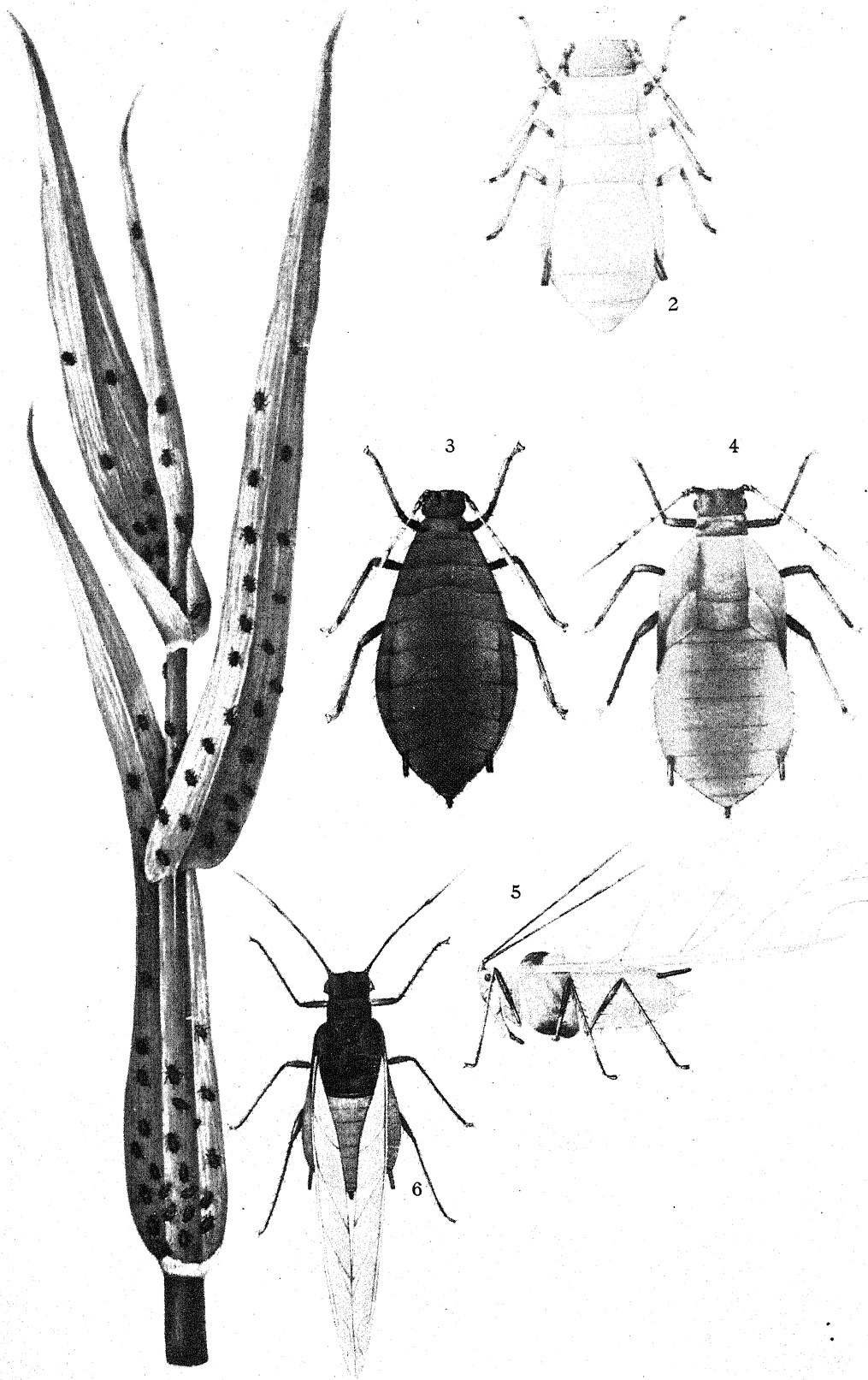
FOOD-PLANTS.—Sugarcane, wheat, juar, paddy, maize, guinea-grass. *sama*.

DESCRIPTION AND LIFE-HISTORY.—The small dry grass-coloured moth lays eggs (Fig. 1, Pl. XI) in clusters usually low down on the leaves. The young caterpillars on hatching bore into the stem and feed on the tissues inside, causing the centre shoot to wither (Fig. 6, Pl. XI). There is generally one caterpillar in an attacked stem. When one stem is finished, the caterpillar comes out and attacks another. A full-grown caterpillar is about an inch long with a pink-coloured smooth body and a black head (Fig. 3, Pl. XI). When full-fed, it pupates (Fig. 4, Pl. XI) either inside the stem or between a leafsheath and stem, from which the moth (Fig. 5, Pl. XI) comes out in due course of time. In good alluvial soil, if one stem is destroyed by this borer, fresh new shoots come out and the damage is not very great, but where there is not much moisture and the soil not good, the death of a shoot means that of a whole plant, and consequently the damage becomes serious. The caterpillars can be found in young shoots from old juar stumps after the wheat crop is reaped.

REMEDY.—The withered plants should be picked off and buried or burnt. At the beginning of the rabi season especially wheat fields should be examined regularly and all the withering shoots destroyed.

Old juar plants should not be allowed to remain in the ground near wheat fields as the young shoots produced in February provide a home for this pest after the wheat harvest.

References.—I. I. P., pp. 122-124.



WHEAT APHIS.

Fig. 1—Part of a plant with Aphides on it. Fig. 2—Young Aphid. Fig. 3—Full grown Aphid. Fig. 4—Nymph of a winged form. Fig. 5—Winged Aphid, side view. Fig. 6—Winged Aphid seen from above.

N.B.—Figures 2–6 are much enlarged.

I.—CEREALS.

HOST : B. WHEAT.—*Triticum vulgare*.

VERN. NAMES.—Beng.—*Gam*, *Godhum* ; Hindi—*Gehum* ; Oriya—*Gahamā*.

PEST—

(c) SUCKING—

WHEAT APHIS.—*Siphonophora granarium*, Kby.

VERN. NAMES.—*Jāb pokā*—Lower Bengal ; *Mechā*, *Lāhi*—Behar.

NATURE OF DAMAGE.—These minute insects suck the sap out of the leaves with their beaks, when the wheat plants are young. They also cluster in large numbers on the young ears and suck out the juices from the soft seed. The grains become light and of poor quality and the yield is materially reduced.

LOCALITY AND TIME OF APPEARANCE.—It is common in the plains of Behar where wheat and barley are grown. The first colonies of this insect are noticed early in November. These are small and scattered and found chiefly among the growing leaves. As the crop grows, the colonies increase and attain their maximum activity in the months of January and February. When the wheat is harvested, they fly away and take shelter in *dhub* grass where they remain during the hot and rainy months.

FOOD-PLANTS.—Wheat and barley.

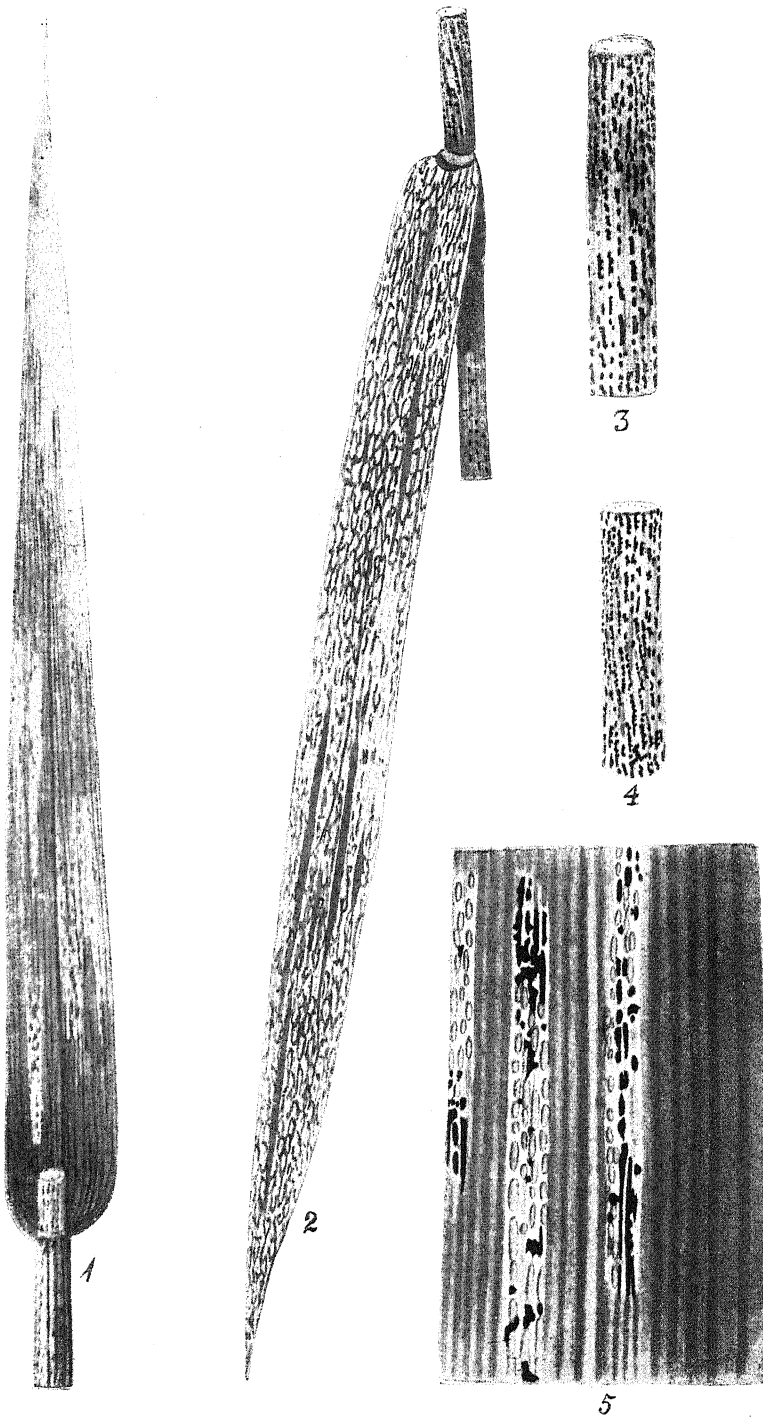
DESCRIPTION AND LIFE-HISTORY.—It is a minute green-coloured aphid, generally wingless, found in clusters on wheat leaves, shoots and ears (Fig. 1, Plate XII). Nearly every individual in a cluster is a female. One peculiarity of this insect is that it can reproduce itself without fertilization. It generally brings forth living young, instead of eggs, and the young ones begin to suck out the sap with their beaks as soon as they are born. A young aphid becomes mature in five or six days after which it brings forth a fresh batch of young insects. From this it can be calculated how enormously they can increase in a short time. They fare best in cloudy and moist days and they are more or less checked by dry hot winds. Since they increase in cloudy weather, the cultivators ascribe their presence to clouds. When the supply of food is exhausted in an area or when a colony becomes big, winged aphids appear (Figs. 5, 6, Plate XII), and go to fresh areas to start new colonies.

ENEMIES.—The Aphids have a large number of enemies. The maggots of *Syrphus* fly kill a good number of them. Ladybird beetles and Lace-wing flies feed greedily on Aphids.

REMEDY.—The first colonies should be carefully looked for and destroyed or else they will spread over the whole field under favourable circumstances. The plants harbouring the first colonies should be uprooted and put in kerosinised water. .

For an experimental crop the first colonies may be sprayed with Crude Oil Emulsion (see Appendix No. IV).

References.—I. I. P., pp. 237-38



YELLOW RUST OF WHEAT AND BARLEY (*PUCCINIA GLUMARUM*).

Figs. 1, 2—Showing different degrees of attack. Figs. 3, 4—Showing teleutospores on stalks. Fig. 5—Showing uredosori and teleutospores on leaf (magnified).

I.—CEREALS.

HOST : B. WHEAT.—*Triticum vulgare*.

VERN. NAMES.—Beng.—*Gam* ; Behari—*Gehum* ; Oriya—*Gahamā*.

C. BARLEY.—*Hordeum hercystichon*.

VERN. NAMES.—Beng.—*Jar* ; Behari—*Jau* , Oriya—*Jau*.

D. OATS.—*Avena sativa*.

VERN. NAMES.—Beng.—*Jai* ; Behari—*Jai* ; Oriya—*Jai*.

PEST—

FUNGUS—

RUSTS.—*Puccinia graminis*, Pers ; *P. glumarum*, Erik and Henn—I .
triticea, Erik ; *P. Lolii*, Neils.

VERN. NAME —Behari—*Harda*.

DESCRIPTION.—The rusts of wheat, barley and oats are so similar in their appearance and in their effect on the crops that they may be described in the same place. Of the above the rust on oats, namely, *P. Lolii*, has so far been found only occasionally and will not be described here. Of the remaining three rusts, two of them, namely, *P. graminis* and *P. glumarum*, occur both on wheat and barley ; and *P. triticea* occurs only on wheat. The cereal rusts are the worst parasites of the cultivated crops and the damage which they cause in India on wheat alone has been estimated at about Rs. 4,00,00,000 annually.

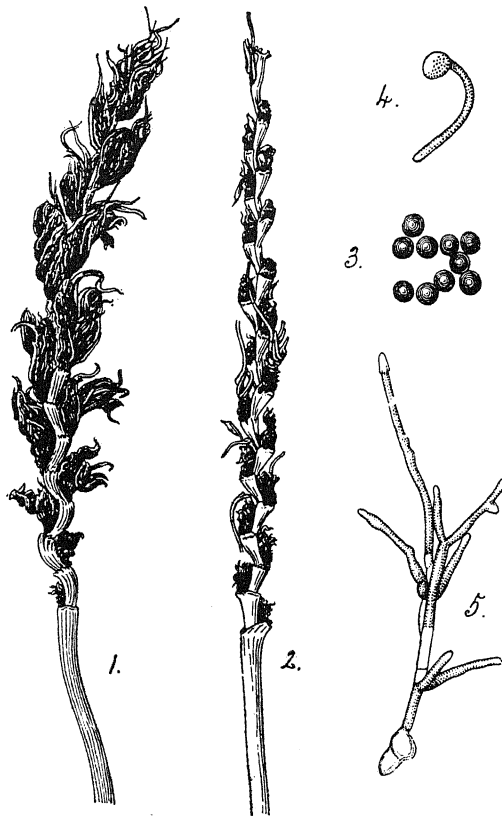
The rusts, as their name implies, produce rusty spots on the culms, leaves, leaf-sheaths and even ears of the wheat or the barley plant (*vide* Plate XIII). These spots are generally oval or elongated (differing slightly according to the different species of the rust), minute and numerous. They appear slightly raised above the surface while remaining at first covered by the epidermis ; subsequently they rupture the epidermis and let loose a powdery substance, the spores of the fungus, varying in colour according to the species of the parasite, such as light-yellow in *P. glumarum*, orange in *P. triticea*, and dark-brown in *P. graminis*. These spores are the reproductive bodies of the fungus and answer to the seeds of the higher plants. They are produced in such enormous quantities that they sometimes lend their colour to the ground under them ; and it is not an uncommon experience with persons travelling through a rust-infected field to have their trousers or *dhoties* coloured by the spores of the parasites. These spores are called the early or uredo-spores ; they serve to disseminate the fungus in

geographical extent. They are followed by another kind of spores known as the late or teleuto-spores which are either produced in the same spots where at first the uredo-spores were produced or are produced in new spots. They are darker and lend their colour to the spots or patches which appear quite black (Fig. 3, Plate XIII). The teleuto-spores are said to propagate the disease from year to year which is perhaps true elsewhere but certainly not in India, where it is not known with certainty as to how infection takes place year after year in the cereals concerned. Too much or too little moisture in the soil and cloudy moist weather seem to serve as predisposing causes of the spread of the disease.

REMEDY.—In the absence of a clear knowledge of the mode of infection it is difficult to suggest any remedy. Ordinary methods of seed treatment have produced no satisfactory result. Attempts are being made to produce rust-resisting varieties of wheat, and the solution of the problem seems to lie in that direction. In some cases early sowing has been recommended.

References.—Mem. D. Ag. I. (Bot. Series), Vol. I, Part 2—Indian Wheat Rusts by E. J. Butler and J. M. Hayman.

PLATE XIV.



LOOSE SMUT OF WHEAT (*Ustilago Tritic.*)

Fig. 1.—An affected ear. Fig. 2.—The same from which the spores have been blown away. Fig. 3.—The smut spores, as seen under the microscope. Figs. 4 & 5.—Germinating spores.

N.B.—Figures 3—5 are very much enlarged.

I.—CEREALS.

HOST : B. WHEAT.—*Triticum vulgare*.

VERN. NAMES.—Beng.—*Gam* ; Behari—*Gehum* ; Oriya—*Gahamā*.

C. BARLEY.—*Hordeum hexastichon*.

VERN. NAMES.—Beng.—*Jav* ; Behari—*Jau* ; Oriya—*Jau*.

D. OATS.—*Avena sativa*.

VERN. NAMES.—Beng.—*Jai* ; Behari—*Jai* ; Oriya—*Jai*.

PEST—

FUNGUS—

SMUT.—*Ustilago tritici* (Pers.) Jens on wheat ; *U. hordei* (Pers.) Kell.
and Sw. on Barley ; *U. avenae* (Pers.) Jens on Oats.

VERN. NAME.—Behari—*Karia*.

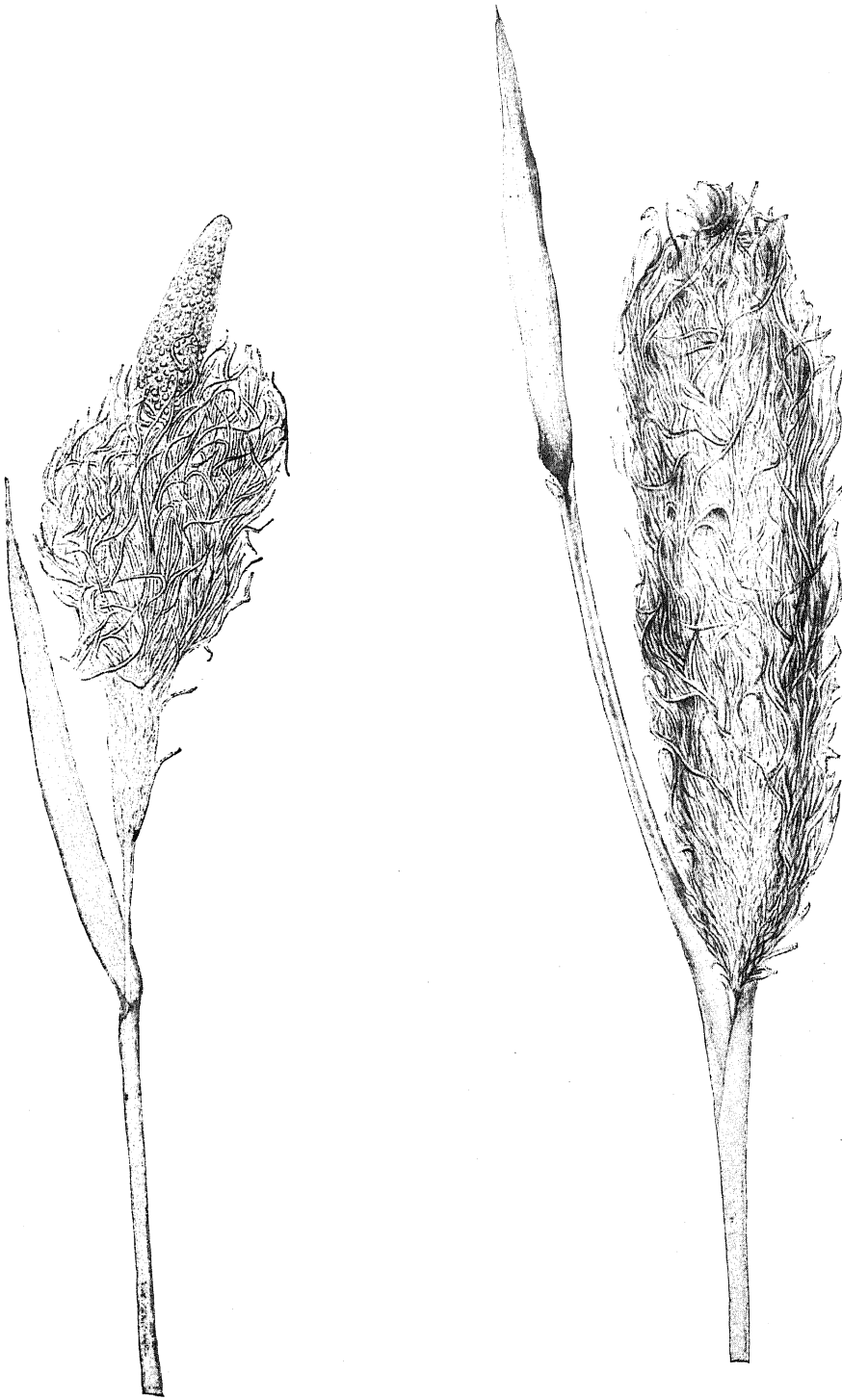
DESCRIPTION.—The smuts of wheat, barley and oats are so similar, both in their appearance and in their effect on the crops, that they may be conveniently described together. They are very common diseases of these crops, but the extent of damage which they cause is not so great as in the case of the rusts, though in badly affected areas they cause appreciable depreciation in the value of the crops.

The smut attacks individual plants and the attacked plant does not yield any grain. The infection takes place in the seedling state in oats and barley by spores of the fungus adhering to the surface of the seed, and at the flowering state of the previous generation in the case of wheat, in which case spores blown into the flower germinate and produce a mycelium in the embryo. During the vegetative growth of the host plant no appreciable difference is manifested between a healthy plant and a diseased plant. At the fruiting time, however, the diseased plants, instead of developing healthy grains, produce black powdery masses on the ears in the places of healthy flowers and fruits (Fig. 1, Plate XIV). These black powdery bodies are the spores (Fig. 3, Plate XIV) of the fungus which are produced in large quantities within the ovaries of the flowers and are at first covered by the ovary walls, which soon rupture, specially in the cases of wheat and oat smuts, and set free the powdery spores which are easily blown away by the wind and distributed all over the field, until only the stalks of the ears with only a few ragged remains of the flowers are left behind (Fig. 2, Plate XIV) ; hence the smuts of wheat and oats are called the “loose

smuts." In the case of barley the masses of spores are hard and persistent and long remain covered by the ovary walls ; they therefore appear somewhat lighter in colour.

REMEDY.—The wheat smut may be checked by sterilizing the seeds in hot water (*vide* Appendix No. X). The oat and barley smuts may be checked by treating the seeds in Formalin or Copper Sulphate solution (*vide* Appendix No. XI), or by sterilizing the seeds in hot water as in the case of wheat smut. If none of these methods are followed, at least care may be taken to select or import seed from a healthy locality where the disease is not prevalent.

PLATE XV.



EARS OF BAJRA AFFECTED BY *SCLEROSPORA GRAMINICOLA*.

I.—CEREALS.

HOST : E. GREAT MILLET.—*Andropogon sorghum*.

VERN. NAMES.—Beng.—*Juwar* : Behari—*Juwar* : Oriya—*Juwar*.

BULLRUSH MILLET.—*Pennisetum typhoideum*.

VERN. NAMES.—Beng.—*Bajra* : Behari—*Bajra* : Oriya—*Bajra*.

ITALIAN MILLET.—*Setaria italica*.

VERN. NAMES.—Beng.—*Kann* : Behari—*Kanni* ; Oriya—*Tanguni*.

PEST—

FUNGUS—

GREEN EAR OR LEAF-SHREDDING DISEASE.—*Sclerospora graminicola* (Sacc.)
Scroet.

DESCRIPTION.—This peculiar disease of the above millets occurs only sporadically except in low-lying ill-drained localities where it occasionally becomes epidemic. Usually it passes unnoticed and possibly causes no appreciable damage. Still the disease is of interest as it provides an example in certain cases of a complete or partial malformation of the inflorescence brought about by a parasitic fungus which, when it attacks the ears, prevents grain from being formed and induces the flowers to assume a leafy appearance, so that the ears look like heads of overcrowded deformed leaves (*vide* Plate XV). This effect of the attack on the ears is most characteristic in the case of bajra where it can be seen in varying degrees of intensity, from instances in which only a few spikelets have been affected to those in which a complete malformation of the ears has taken place. In juwar the effect of the attack on the ears is somewhat different, the ears either not being formed at all or being deformed, reduced or otherwise variously modified. The effect on the leaves, which show the earliest symptom of the disease, is also peculiar as it tends to shred the leaf longitudinally into fibres ; hence the name “ leaf-shredding disease.” At first they turn pale and somewhat whitish in colour ; at this stage careful examination may show a greyish felty coating on them bearing an early type of fruit body of the fungus. This soon disappears, and is followed by a more persistent type of spore which is so large that it could be seen with the naked eye by holding a leaf against the light when very minute reddish spots, each representing a spore, may be seen arranged in longitudinal rows. These spores are produced in large quantities and are liberated with the shred-

ding or splitting up of the leaves lengthwise, which takes place at this stage owing to the disorganization of certain tissues of the leaves.

REMEDY.—To prevent the spread of the disease destroy the diseased plants.

References :—Mem. D. Ag. I. (Bot. Series), Vol. II, No. 1—Some diseases of cereals caused by *Sclerospora graminicola* by Dr. E. J. Butler.

I.—CEREALS.

HOST : E. GREAT MILLET.—*Andropogon sorghum*.

VERN. NAMES.—Beng.—*Jucar* ; Behari—*Jucar or Sahuma* ; Oriya—*Jumar*.

PEST—

FUNGUS—

RUST—*Puccinia purpurea*, Cooke.

DESCRIPTION.—The rust of the great millet is a very common and damaging disease, frequently found where the crop is cultivated. It attacks the leaves and weakens the plants, with the result that either grains are not developed or they become ill-formed and much lighter than normal grains. Two kinds of spores of the fungus are developed on the leaves ; an early type, which appears on both surfaces of the leaves in oval or elongated slightly raised patches which are bright red or purple in colour and at first remain covered by the epidermis. When the spores are mature the epidermis is ruptured and the yellowish brown powdery spores are liberated. These spore-patches are sometimes developed so profusely that they thoroughly discolour the leaves. The late type of spores are usually developed on the undersurface of the leaf. They are darker in colour and more or less scattered.

A similar rust caused by *Puccinia pennegeti*, Zimm., affects the bajra crop.

REMEDY.—Seed selection and early sowing may be tried.

I.—CEREALS.

HOST : E. GREAT MILLET.—*Andropogon sorghum*.

VERN. NAMES—Beng.—*Juwar* ; Behari—*Juwar* ; Oriya—*Juwar*.

PEST—

FUNGUS—

SMUT.—*Cintractia sorghi-vulgaris* (Tul.), Clint.

DESCRIPTION.—There are several smuts of the great millet of which the above has been found in Bengal. The smuts are said to be the most destructive parasite of the crop, causing considerable damage. The above smut, unlike most cereal smuts, attacks only individual grains and not the whole head. Yet in an attacked ear a large number of grains are found to be so affected ; even those that are not attacked by the smut are found to be deformed. The smutted grains are easily recognised by their larger size and somewhat darker colour. They are lightly covered by a thin membrane which soon bursts and lets loose a dark brown powdery mass of spores. When the spores are blown away by the wind, a central column often remains behind.

REMEDY.—Treatment of seeds either by the hot water method (see Appendix No. X) or by Copper Sulphate solution (see Appendix No. XI) is recommended.

I.—CEREALS.

HOST : E. MAIZE—*Zea mays*.VERN. NAMES.—Beng —*Makkā* ; Hindi—*Makāi*, *Janerā* ; Oriya—*Makā*.

PEST—

(a) LEAF-EATING—

ORANGE BANDED AMSACTA.—*Amsacta lactinea*, Cram.VERN. NAMES.—*Samburā*—Cuttack ; *Palu Pok*—Sambalpur ; *Bhuū*—Behar.

NATURE OF DAMAGE.—The caterpillars of this moth feed on the leaves of maize, paddy, *til*, juar, jute, etc.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Cuttack attacking jute and from Dumka (Sonthal Pergannahs) attacking maize. It generally appears in July and August.

FOOD-PLANTS.—Maize, jute, sweet potato, sunflower, paddy, *til*, juar, weeds.

DESCRIPTION AND LIFE-HISTORY.—It is a white moth of medium size, with black spots on the wings and red line along the anterior margin of the first pair of them. The body is bright orange above, with black bands and spots. The female moth lays eggs on flat expanses on the leaves of the food-plants, each mass containing several hundreds. These eggs hatch in three to four days and the young caterpillars on coming out begin at once to feed on the leaves. At first they remain crowded together, but as they grow they move about for food and become distributed over a large number of plants. A full-grown caterpillar measures about an inch and a half, has a dark body covered with dense tufts of hair. When full-fed, it crawls down to the ground and pupates in the soil. In about a fortnight, moths come out of the pupæ and lay eggs on fresh plants.

REMEDY.—These moths are strongly attracted by light and a considerable number can be destroyed by means of lamp trap (see Appendix No. VI). A lamp trap consists of any lantern, which will burn well in the field, placed on a big shallow tray containing water and some kerosine oil. This is to be placed on a raised place in the field. The moths being attracted by light, come to it, fall into the kerosinised water and die. The trap should be set on successive nights after heavy rain, as the moths usually emerge in large numbers at that time. They can thus be killed before they can lay their eggs. In the case of an attack restricted to a small area, trenches should be dug round the field and filled with water, to prevent the caterpillars crossing to other fields.

A good spraying with Lead Chromate or Lead Arseniate is very efficacious.

References.—I. I. P., p. 192.

A. J. I., Vol. I, pp. 187-192. Hairy Caterpillar Pests of Crops by
H. M. Lefroy.

A. J. I., Vol. V, pp. 205-212. Hairy Caterpillars in the South Arcot
District, Madras, by Y. R. Rao.



PESTS OF PULSES.

Fig. 1—Greasy surface caterpillar. Fig. 2—The moth sitting on plant. Fig. 4—Gram caterpillar eating the seeds of a pod. Fig. 5—Its moth. Fig. 6—Caterpillar of khesari pod-borer feeding on seeds inside a pod. Fig. 7—Its moth. Fig. 8—Moth of mung pod-borer. Fig. 9—A semilooping caterpillar which eats leaves. Figs. 10 & 11—Moths of two different species of semilooping caterpillars.

II.—PULSES.

PEST—

(a) LEAF-EATING—*Plusia* spp.

NATURE OF DAMAGE.—The caterpillars of these moths feed on the leaves of peas, gram, etc. When abundant, they defoliate a crop completely. They do not spare the newly-formed pods.

LOCALITY AND TIME OF APPEARANCE.—In 1912 it was reported from many places damaging peas in *chaur* land. It damaged several hundred bighas in Bhagalpur and 200—300 bighas at Mokameh. It generally appears in December and January.

FOOD-PLANTS.—Gram, pea, linseed, lucerne, cruciferous vegetables and weeds.

DESCRIPTION AND LIFE-HISTORY.—The moths are of medium size (Figs 10 & 11, Plate XVI), and lay eggs on leaves of food-plants at dusk. Each female moth lays from 400—500 eggs. These hatch within a week and the young green semi-looping caterpillars on emerging at once start feeding on the leaves. The length of this stage is from 20—30 days. A full-grown caterpillar is of a bright green colour with white longitudinal stripes on the back and is about an inch and a half long. The body tapers gradually from the hind end towards the head. It moves with a semi-looping motion, *i.e.*, humps its back into a loop (Fig. 9, Plate XVI). When full-grown, it pupates in folded leaves. The moth emerges from a pupa in one or two weeks.

REMEDY.—Drag a long thick rope moistened with kerosine oil. across an affected field, brushing the plants vigorously. If this is done twice every day for two or three days consecutively, the caterpillars will leave the field.

II.—PULSES.

PEST—

(d) POD-EATING—

GRAM CATERPILLAR.—*Chloridea obsoleta*, Fbr.

VERN. NAMES.—*Kūtri pokā*. *Chorā pokā*—Lower Bengal: *Hurni pok*—Sambalpur; *Kajrā*—Parts of Behar.

NATURE OF DAMAGE.—The caterpillar of this moth is a pod-borer, *i.e.*, it makes holes in the side of the pod and eats the seed inside. As a rule, it feeds on the pods by boring in from outside to reach the seed, but never going inside the pod. When one seed is finished, it moves to the next.

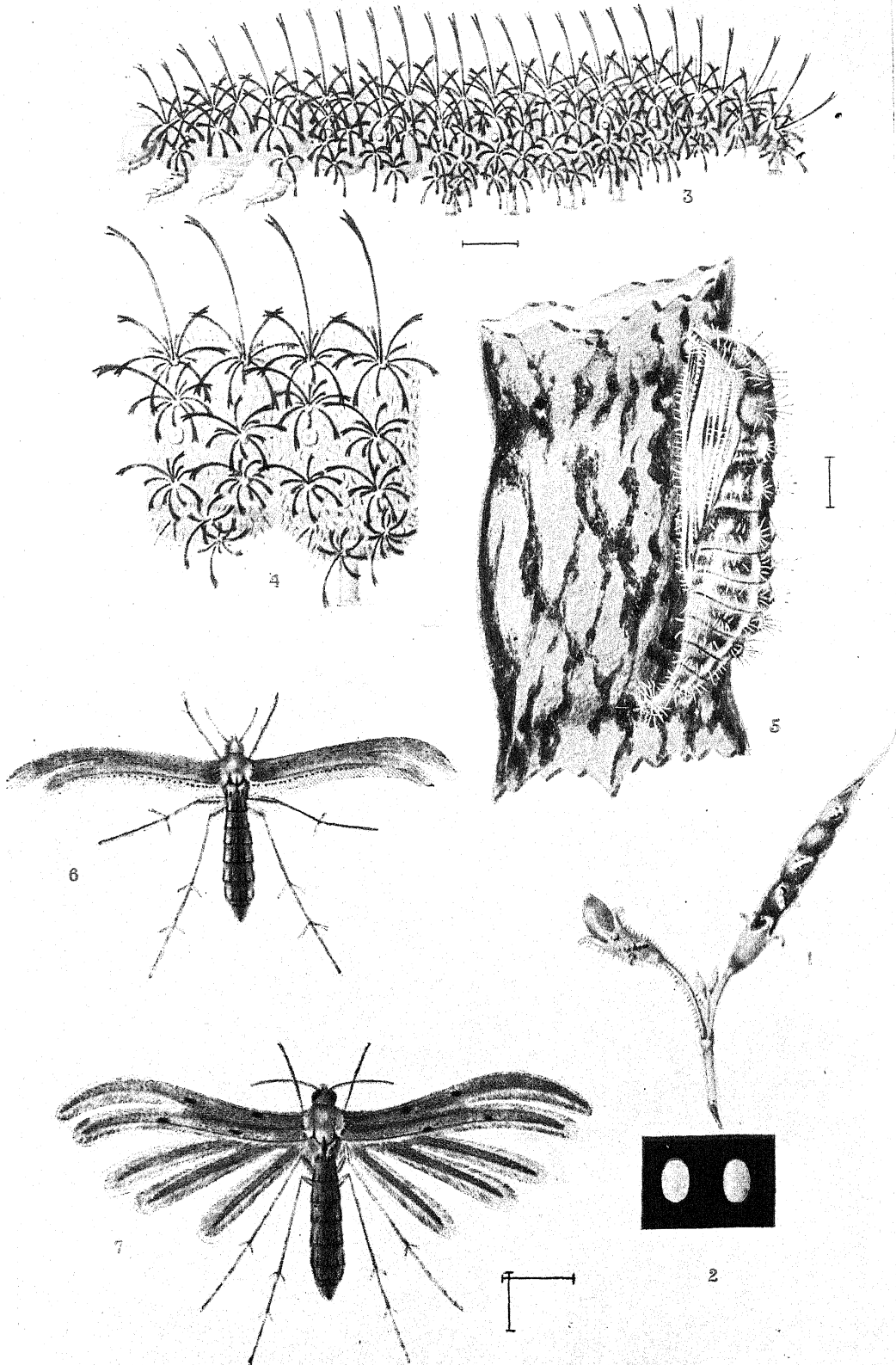
LOCALITY AND TIME OF APPEARANCE.—It occurs all over Bengal. In Behar, it attacks gram in February and early March. From this time onwards till November it has several broods on the plants mentioned below. Where the winter is mild, it breeds throughout the year.

FOOD-PLANTS.—Gram, peas, opium, tobacco, lucerne, *ganja*, indigo, *arhar*, tomato, sunflower heads, castor seeds, *bajra* heads, etc. It has a large number of food-plants, of which gram and opium are the most common.

DESCRIPTION AND LIFE-HISTORY.—It is a medium-sized moth, the colour varying from olive grey to red brown (Fig. 5, Plate XVI). There is a dark speck and a dark area near the margin of each forewing. The female moth lays eggs singly on leaves, flowers and pods of the food-plants. In three or four days the eggs hatch, and a young caterpillar feeds on leaves for a short time. It then attacks the pod, makes holes in it and eats the seeds from outside (Fig. 4, Plate XVI), never bodily entering the pod and remaining there. It thus goes on for a fortnight or so, after which it comes down to the soil to pupate. A full-grown caterpillar is about one and half inches long, of a greenish colour, with brown stripes. The pupal stage is about 10—12 days.

REMEDY.—Handpicking is the only remedy possible.

References.—I. I. P. pp. 144-46.



TUR PLUME MOTH.

Fig. 1.—A pod with eggs on it. Fig. 2.—Eggs magnified. Fig. 3.—Caterpillar as seen from the side. Fig. 4.—Two segments of the caterpillar from side. Fig. 5.—Pupa on portion of a pod. Fig. 6.—Moth as seen when sitting on plants. Fig. 7.—Moth as seen when flying.

N.B.—The insect is here shown very much enlarged.

II.—PULSES.

PEST—

(d) POD-EATING—

TUR PLUME MOTHS.—*Eelastis atomosa*, Wlsm.

NATURE OF DAMAGE.—The caterpillars of this tiny moth feed on the seeds of *rahar* or *arhar* (*Cajanus indicus*) when it ripens. They do not enter bodily into the pods but bore into the pod from outside and eat the seeds from outside. After eating one seed the caterpillar goes on to the next and makes another hole there.

LOCALITY AND TIME OF APPEARANCE.—It is common in Behar and appears during cold weather. Where this crop is grown on an extensive scale the damage done is not appreciable, but where it is limited the loss is naturally considerable.

FOOD-PLANTS.—*Arhar* and *kulthi*.

DESCRIPTION AND LIFE-HISTORY.—It is a very small moth, of a brownish colour with long narrow wings (Figs. 6, 7, Plate XVII). Eggs are laid by the female moths on pods and flowers (Fig. 1, Plate XVII). These hatch within a week and the young caterpillars on coming out start making holes in the pods and eating the seeds from outside. A caterpillar becomes full-grown in about four weeks when it measures one-half of an inch. It is of a green or greenish brown colour with dense tufts of spines or hairs on the body (Fig. 3, Plate XVII). When full-fed it pupates on the pod (Fig. 5, Plate XVII), and comes out as a moth after seven days.

REMEDY.—Handpicking or shaking the caterpillars into a tin containing kerosine and water by jerking the twigs while passing by the plants, is a very efficient method of killing them.

In small plots a good spraying with crude oil emulsion is very effective (see Appendix No. IV).

In case the pest is likely to become serious its increase can be prevented by not growing crops of other legumes, *seem*, etc., which would ripen at different times throughout the year. The caterpillars live on other pulses through the rains and then attack the *arhar* plants in February-March.

References.—I. I. P., pp. 140-141.

II.—PULSES.

PEST—

(e) STEM-CUTTING—

GREASY SURFACE CATERPILLAR.—*Agrotis ypsilon*, Rott.

NATURE OF DAMAGE.—The caterpillars of this moth are a serious pest of pulse crops. They remain concealed in cracks in the soil during the day, come out after dark and cut off the stems of young plants near the surface of the ground. The cut plant is then bodily carried under the soil and its leaves eaten during the day time. The heaviest attack occurs on *rabi* pulses on lands that have been under flood water during the rainy season.

LOCALITY AND TIME OF APPEARANCE.—It annually destroys several thousands of acres of *rabi* pulses on the Mokameh Tal during October and November. Less severe attacks have been reported from Dharara, Sabour, Colgong and Pakur in Behar. It frequently attacks potato, cabbages, etc., in vegetable gardens in Behar in December and January. It generally appears in November and remains active all through the cold months, disappearing in March or even later.

FOOD-PLANTS.—Gram, lentil, *khesari*, peas, tobacco, opium, lucerne, cabbage, groundnut, potato, mustard, linseed, wheat, barley, etc.

DESCRIPTION AND LIFE-HISTORY.—It is a dark coloured medium sized moth (Fig. 3, Plate XVI), coming out only at night. Each female moth lays a large number of small white eggs (about 350) on weeds or stones, in grass borders, etc. The eggs hatch within a week and the young caterpillars on emerging feed on the fallen leaves on the ground for a few days. As it grows it goes into cracks in the soil during day, and after dark comes out to bite through the base of young plants. Each caterpillar cuts more plants than it can eat and the damage done is thus very great. The larval period is about a month, being a few days more in winter and several days less in hot weather. A full-grown caterpillar is about $1\frac{3}{4}$ " long, of a dark colour and greasy to touch (Fig. 1, Plate XVI). When full-fed it pupates (Fig. 2, Plate XVI) in the soil in an earthen chamber and comes out as moth to lay eggs on fresh unaffected areas. The pupal stage varies from 10 to 30 days.

ENEMIES.—A fly looking more or less like the common house flies lays eggs on the body of this caterpillar. The fly maggots after hatching go inside the body of the host and destroy it, by feeding on its tissues.

Another very small insect, akin to wasps, is a serious enemy of these caterpillars. The eggs are laid on the body and the young ones on hatching feed on the tissues

inside the body. One hundred and twenty-five of these young ones have been found in the body of a single caterpillar (see Appendix No. VII).

REMEDY.—In small areas handpicking is the best remedy. The caterpillars can easily be located in the field, by the green leaves of the plants cut at night sticking out of the surface of the soil. On digging the soil near a newly cut plant, the caterpillar is found within an inch from the surface. They should be collected and put in a tin containing water and kerosine.

At Pusa smooth holes were dug in the fields, into which the caterpillars fell while out at night in search of food, and being cannibalistic in nature they destroyed each other.

Poisoned baits scattered over an affected area have also been found to be effective at Pusa. The procedure is as follows :—

Mix one maund of bhusa with six gallons of water, in which one seer of white arsenic and two seers of gur or jaggery have been dissolved. This mixture will do for 5 acres, and the paste is to be put out on the area in small heaps about two yards apart.

In very big areas like Mokameh Tal lands it is best to pick the first brood off and destroy it. The number of the first brood is very small and so it is easy to destroy it and thereby minimize the damage done by the second brood.

The moths can be caught at night in a patent trap devised by Messrs. Andres Maire, Egypt, which trap is under experiment in India

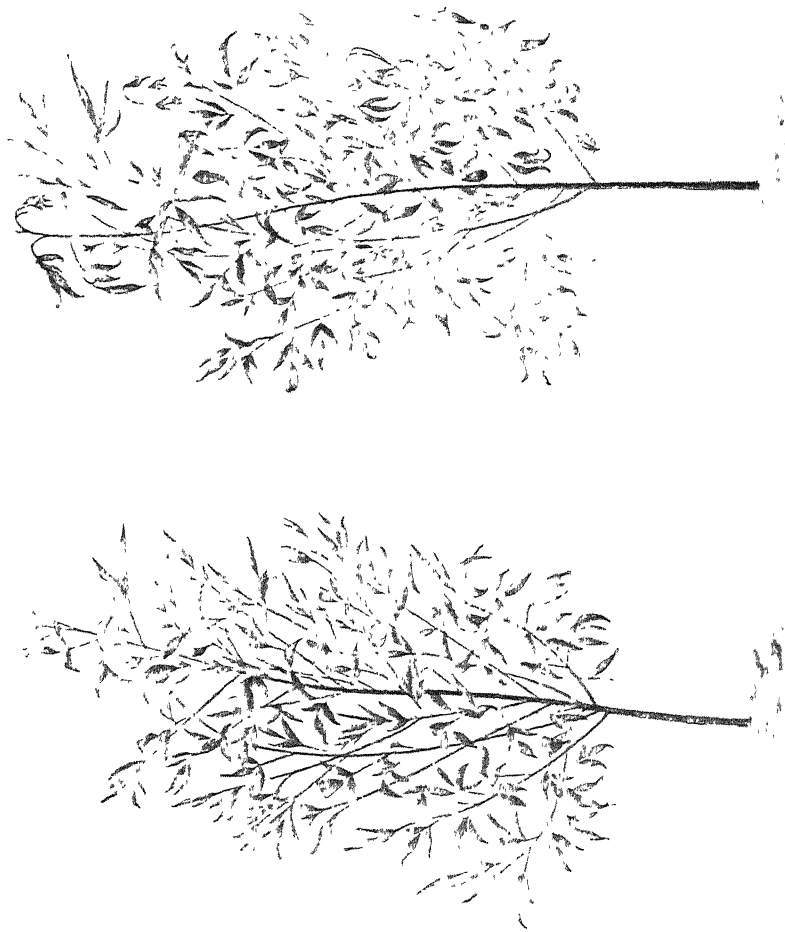
References.—Mem. D. Ag. I., Vol. I, No. III (Ent. Series). The Indian Surface Caterpillars of the genus *Agrotis* by H. M. Lefroy and C. C. Ghosh.

B. Q. J., Vol. IV, No. 4. The Insect Pests of Mokameh Tal, by E. J. Woodhouse and H. L. Dutt.

B. A. J., Vol. I, No. 1. Surface Caterpillar on Tal lands, by E. J. Woodhouse and H. L. Dutt.

A. J. I., Vol. VII, No. 4. The Caterpillar Pest of the Mokameh Tal lands, by E. J. Woodhouse and T. Bainbrigge Fletcher.

PLATE XVIII



SE OF PIGEON PEA (Rahar) CAUSED BY FUSARIUM UDUM.
Healthy. Fig. 2.—Partly wilted. Fig. 3.—Completely wilted plant.

II.—PULSES.

HOST : PIGEON PEA.—*Cajanus indicus*VERN. NAMES.—Beng.—*Arhar* ; Behar—*Rohar* ; Oriya—*Harura*.GRAM.—*Cicer arretinum*.VERN. NAMES.—Beng.—*Chola* ; Behar—*Chana* ; Oriya—*Bunta*.COW PEA.—*Vigna catiang*.VERN. NAMES.—Beng.—*Barbati* ; Behar—*Bora* ; Oriya—*Barbati*.

PESTS—

FUNGUS—

WILT.—*Fusarium udum*, Butl.

DESCRIPTION.—The wilt diseases of pigeon pea, gram and cow pea are probably caused by the same parasitic fungus as indicated above. The symptoms of the diseases and their effects on the crops are at any rate very similar, though *Fusarium udum* has so far been identified with the wilt disease of pigeon pea alone. A few other crops such as cotton, indigo and san hemp are also liable to a similar attack of wilt disease with similar results in which also the parasite is either the same or an allied species of the same organism. The disease is widespread and very destructive to the pigeon pea which invariably suffers more or less from the effect of its attack. Plants of all ages are attacked and the disease may spread from a centre or may affect individual plants. The chief symptom of the disease, as its name implies, is the wilting or withering of the plants which takes place quite suddenly (*vide* Plate XVIII). In its effect the disease is more or less similar to an attack of white ants from which it should be distinguished by carefully pulling out the attacked plants and examining them for any signs of damage by the termites. In the absence of any such the roots and the collar may be examined after removing the bark which will appear blackened or otherwise discoloured if attacked by the wilt disease. As to the mode of infection, the fungus remains in the soil and enters the plant probably through some fine root or rootlet in contact with it ; it then spreads within the vascular tissues of the roots, collar and some portion of the stem, sometimes so profusely that in a badly affected plant almost all the vessels are found choked with its threads, so that no transmission of water could be carried on and the plant in consequence withers.

REMEDY.—Sterilization of the soil by injecting Formalin is said to be effective in similar diseases, but this is practicable only in pot cultures ; in field practice the cost is sure to be prohibitive. A suitable rotation of crops keeps the disease in check and may be carried out with advantage, wilt resisting varieties of pigeon pea will probably supply the best remedy. All diseased plants should be removed from the field and burnt.

References.—Mem. D. Ag. I. (Bot. Series), Vol. II, No. 9. The Wilt Disease of Pigeon Pea, etc, by Dr. E. J. Butler.

II.—PULSES.

HOST : FIELD AND GARDEN PEAS.—*Pisum arvense* & *P. sativum*.

VERN. NAMES.—Bengali—*Deshi* & *Bilati Matar* ; Behari—*Matar* ; Oriya—*Matara*.

LENTILS.—*Lens esculenta*.

VERN. NAMES.—Bengali—*Masuri* ; Behari—*Masuri* ; Oriya—*Masuri*.

BROAD BEANS.—*Vicia faba*.

VERN. NAMES.—Bengali—*Bakla* ; Behari—*Baklu*.

PEST —

FUNGUS—DOWNY MILDEW.—*Peronospora viciae*, de Bary.

DESCRIPTION.—The downy mildew of the above crops also attacks a few other leguminous plants. The seat of the attack is the undersurface of the leaves which becomes covered by slightly pinkish downy patches. In moist weather these patches expand and cover the whole surface of the leaves. In severe cases the upper surfaces of the leaves and even the pods may be attacked resulting in a soft rot and total or partial failure of the crop.

REMEDY.—The disease may be kept in check by spraying with dilute Bordeaux mixture (*vide* Appendix No. IX) at an early stage of its appearance. In case of small areas, as of garden peas the plants may be dusted with a mixture of sulphur and lime (*vide* Appendix No. XII). All diseased parts of the plants must be removed from the field and burnt as the resting spores of the fungus are found in them. These unless removed in time may propagate the disease in the following year. The garden should also be kept clear of all leguminous weeds as the disease is known to occur on some of them and may pass from these to the cultivated crops.

II.—PULSES.

HOST : FIELD AND GARDEN PEAS.—*Pisum arvense* & *P. sativum*.

VERN. NAMES.—Beng.—*Deshi* & *Bilati Matar* ; Behari—*Matar* ; Oriya—*Matura*.

LENTILS.—*Lens esculenta*.

VERN. NAMES.—Beng.—*Masuri* ; Behari—*Masuri* ; Oriya—*Masuri*.

BROAD BEANS.—*Vicia faba*.

VERN. NAMES —Beng.—*Bakla* ; Behari—*Bakla*.

PEST—

FUNGUS—POWDERY MILDEW.—*Erysiphe Polygoni*, D. C.

DESCRIPTION.—The above crops are also liable to a powdery mildew which is even more destructive than the downy mildew. It spreads rapidly in moist weather and frequently attacks late crops. When it attacks young plants the loss is very great.

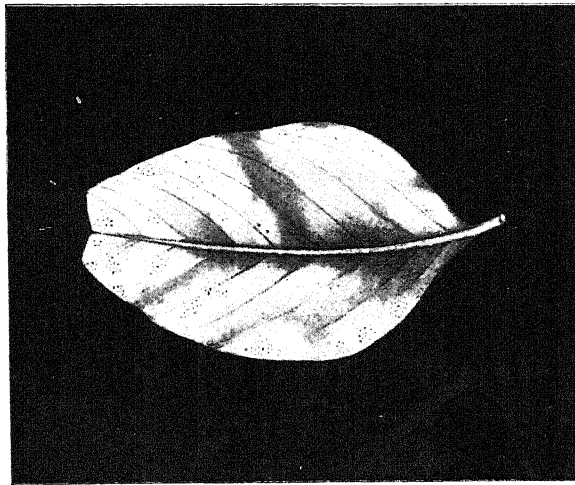


PLATE XIX.—POWDERY MILDEW OF PEA (*Erysiphe Polygoni*).
The white areas with minute black dots are due to the attack.

All parts of the diseased plants, namely, the leaves, stems and even the pods become covered by a whitish or greyish coating (*vide* Plate XIX) which can be easily rubbed

off by the finger. The fungus fixes itself firmly within the cell on which it feeds while it spreads on the surface. The white powdery spores are produced in large quantities which are easily blown away and deposited on other leaves thus spreading the disease.

REMEDY.—The disease may be kept in check by spraying with dilute Bordeaux mixture (*vide* Appendix No. IX) at an early stage of its appearance. In the case of small areas, such as in plots of garden peas, the plants may be dusted with a mixture of sulphur and lime (*vide* Appendix No. XII). All diseased parts of the plants must be removed from the field and burnt as the resting spores of the fungus are found in them. These, unless removed in time, may propagate the disease in the following year. The gardens should also be kept clear of all leguminous weeds as the disease is known to occur on some of them and may pass from those to the cultivated crops.

II.—PULSES.

HOST : MUNG—*Phaseolus radiatus*.

VERN. NAMES.—Beng.—*Mung* ; Behari—*Mung* ; Oriya—*Munga*.

COUNTRY BEAN—*Dolichos lablab*.

VERN. NAMES.—Beng.—*Sim* ; Behari—*Sim* ; Oriya—*Sima*.

PEST—

FUNGUS—

RUST.—*Uromyces appendiculatus*, Link.

DESCRIPTION.—Much injury is caused to the above crops by the rust which causes the leaves to fall off early and thus prevents the development of the fruits. The parasite

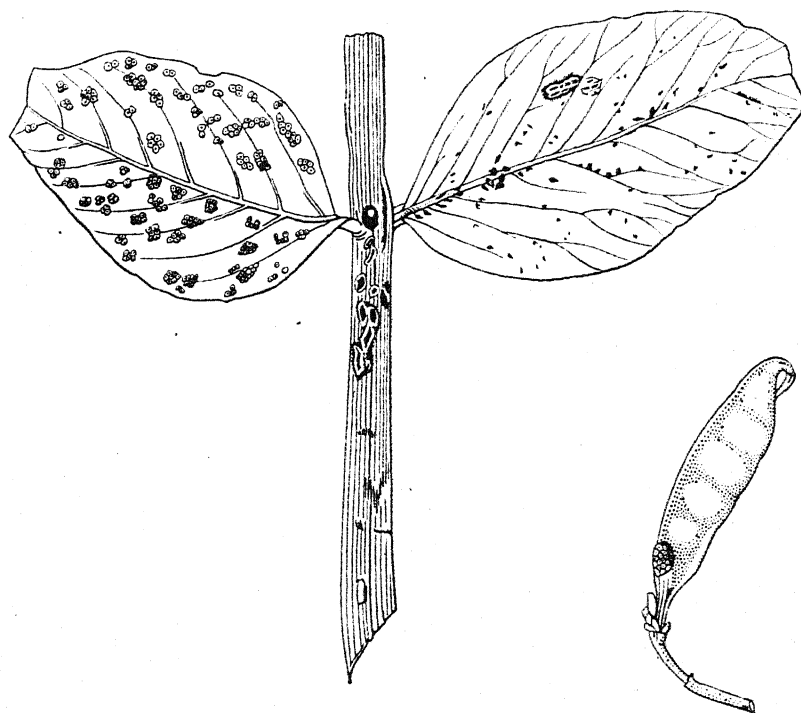


PLATE XX.—RUST OF PEA (*Uromyces fabae*.)

Showing the cluster cups on the pod and the left hand leaf and the uredo-teleuto spots on the right hand leaf and the stalks.

is represented by the three different types of its fruit bodies which appear one after the other on the leaves as minute spots or pustules (*vide* Plate XX). The first to appear

are the "Cluster cups" which are bright yellow in colour; they are followed by the uredo spots which are dark brown in colour; these in their turn are followed by the teleuto spots which are almost black in colour. These fruit bodies and particularly the last two forms are produced in such enormous numbers, that their effect on the plant cannot but be disastrous.

A similar disease caused by *Uromyces fabae* DE BARY attacks peas, lentils, etc., with similar results.

REMEDY.—No remedy seems to have been tried as yet. Where the disease is severe a weak solution of Bordeaux mixture (*vide* Appendix IX) may be applied early as an experiment. Diseased leaves should not be allowed to remain in the field as they may propagate the disease in the following year.

II.—PULSES.

HOST : MUNG—*Phaseolus radiatus*.

VERN. NAMES.—Beng.—*Mung* ; Behari—*Mung* ; Oriya—*Munqa*.

COUNTRY BEAN—*Dolichos lablab*.

VERN. NAMES.—Beng.—*Sim* ; Behari—*Sim* ; Oriya—*Sima*.

PEST—

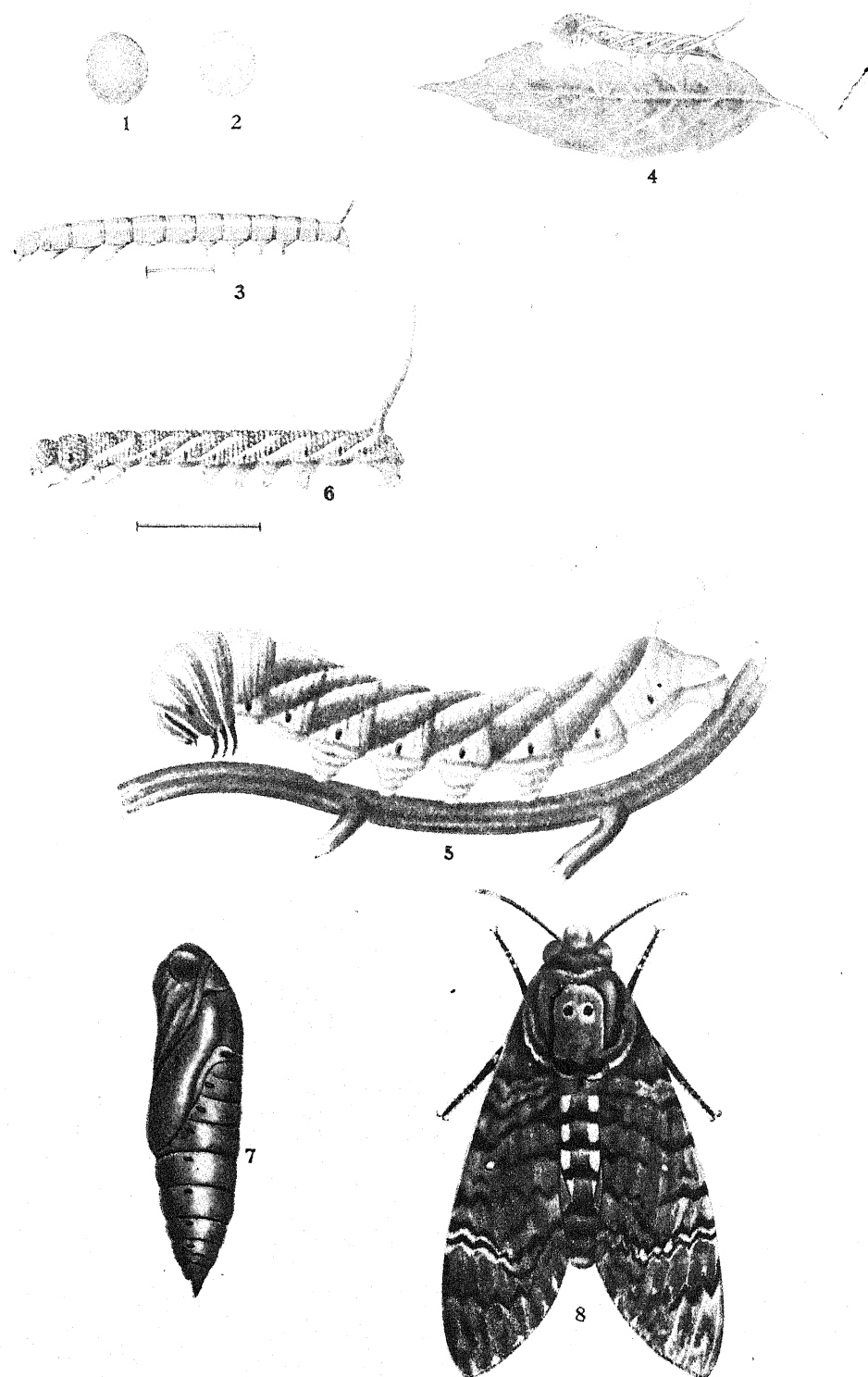
FUNGUS—

LEAFSPOT DISEASE.—*Cercospora cruenta* Sacc. on *Phaseolus radiatus*.

C. Dolichi E. & E. on *Dolichos lablab*.

DESCRIPTION.—The leafspot diseases of the above crops are very similar and are caused by different species of the same fungus. *Cercospora cruenta* also attacks a few other species of *Phaseolus* such as *P. mungo* (*Muskalai*) and *P. aconitifolius* (*Bhringi*). The loss is considerable and the attacked plants produce very few pods. The disease is at first marked by the production of very minute rusty brown spots on the surface of the leaf. These spots are different from the rust spots in the fact that they are not raised above the surface of the leaf as the rust spots are. These spots also increase in size and are often converted into shotholes owing to the disorganization of the tissues. The spores of the fungus are produced in these brown spots and are easily blown away by the wind and deposited on healthy leaves thus spreading the disease.

REMEDY.—The disease may possibly be kept in check by spraying with a dilute solution of Bordeaux mixture (*vide* Appendix No IX), and repeating the process occasionally. The field should be kept clear of all diseased leaves as they might otherwise propagate the disease in the following year.



TIL SPHINX.

Figs. 1, 2.—Eggs. Figs. 3-6.—Caterpillars. Fig. 7.—Pupa. Fig. 8.—Moth.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

III.—OIL SEEDS.

HOST : B. TIL.—*Sesamum indicum*.VERN. NAMES.—Beng.—*Til* : Hindi—*Til* . Oriya—*Khasā*, *Tilā*.

PEST—

(a) LEAF-EATING —

TIL HAWK MOTH.—*Acherontia styx*. F.

NATURE OF DAMAGE.—The big caterpillars of this moth feed on the leaves of til.

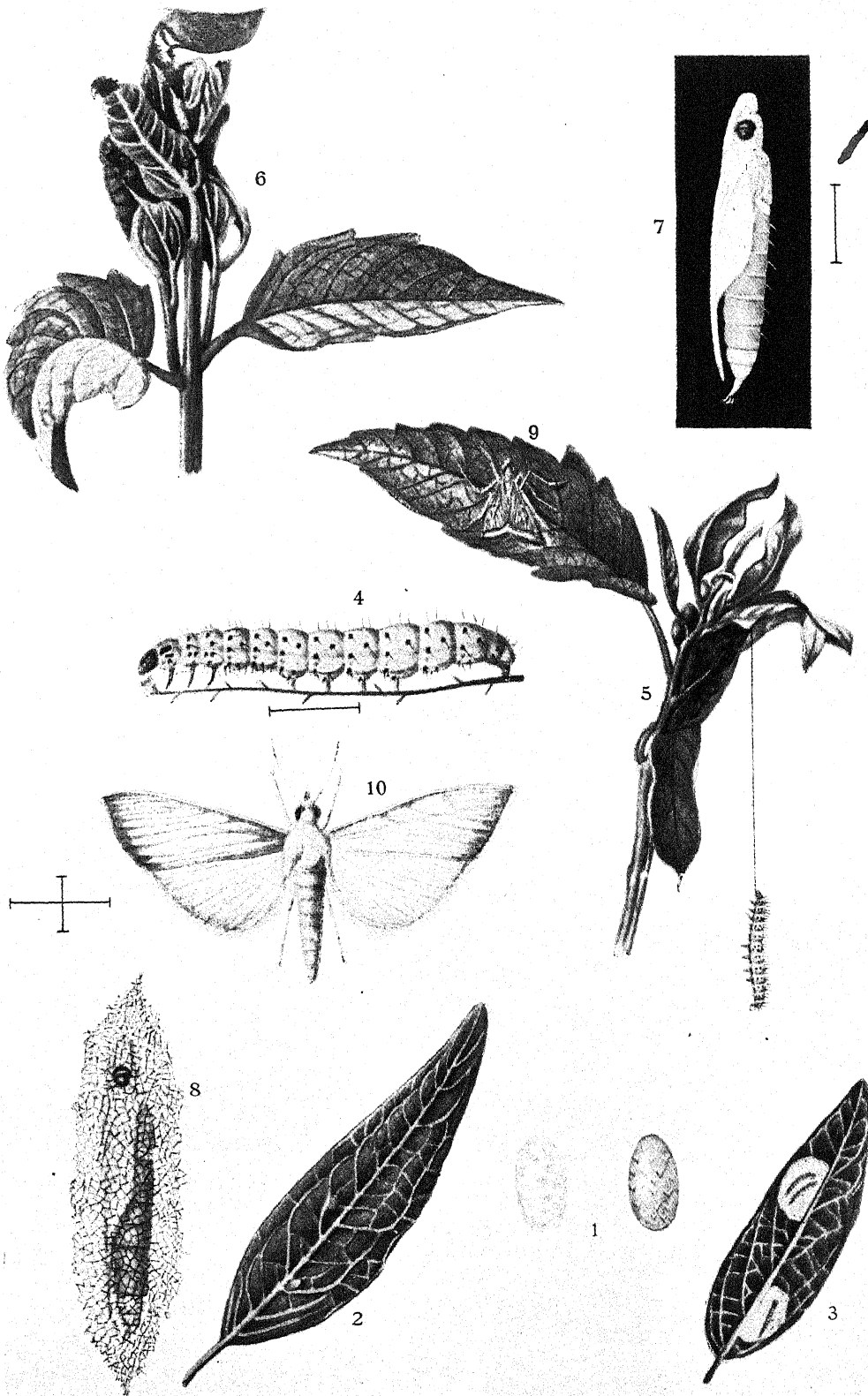
LOCALITY AND TIME OF APPEARANCE.—Though not an important pest of til, it is often found feeding on its leaves. It has, however, not been reported to have caused serious damage to the crop. It may occur anywhere in the plains of our area where til is grown.

FOOD-PLANTS.—*Til*, *kulthi*, potato.

DESCRIPTION AND LIFE-HISTORY.—It is a big moth, with the forewings mottled in brown and grey and the hind wings yellow with black marks (Fig. 8, Plate XXI). It has a dark head and thorax marked with a death's head and thick yellow body with black bands above, and can fly very swiftly like other Hawk moths. The female moth lays eggs on the undersurface of the leaves of its food-plants. The colour of these eggs turns from green to yellow and in four or five days they hatch (Figs. 1, 2, Plate XXI). The young caterpillars on coming out begin to feed on the leaves (Fig. 4, Plate XXI). A full-grown caterpillar is of a bright green colour, with light oblique yellow stripes on each side and a horn like process on the hind end of the body (Fig. 5, Plate XXI). When ready to pupate it changes its colour and becomes deep brown. The larval life is unusually long, about two months, and during this period the caterpillar changes its skin several times. When full grown it leaves the plant, buries itself in the soil and pupates there (Fig. 7, Plate XXI). The moth finally emerges after from one to three months.

REMEDY.—Hand picking is the best method of checking it. Since the caterpillars are conspicuous, they can be easily seen in the fields. They may be collected and thrown into a kerosine tin containing water.

Reference.—I. I. P., pp. 160-161.



TIL LEAF ROLLER.

Fig. 1.—Eggs magnified. Fig. 2.—Eggs on a leaf. Fig. 3.—Young caterpillars on a leaf. Fig. 4.—Caterpillar as seen from the side. Fig. 5.—Affected plant with withered top-shoot and a caterpillar descending to the ground. Fig. 6.—Webbed top-shoot. Fig. 7.—Pupa from side. Fig. 8.—Cocoon taken out of the webbed top leaves. Fig. 9.—Moth on leaf. Fig. 10.—Moth as seen flying.
N. B.—In case where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

III.—OIL SEEDS.

HOST : B. TIL.—*Sesamum indicum*.VERN. NAMES.—Beng.—*Til* ; Hindi—*Til* ; Oriya—*Khasū Tila*.

PEST—

(b) LEAF-ROLLING—

TIL LEAF-ROLLER.—*Antiquastra catalanalis*, Dp.

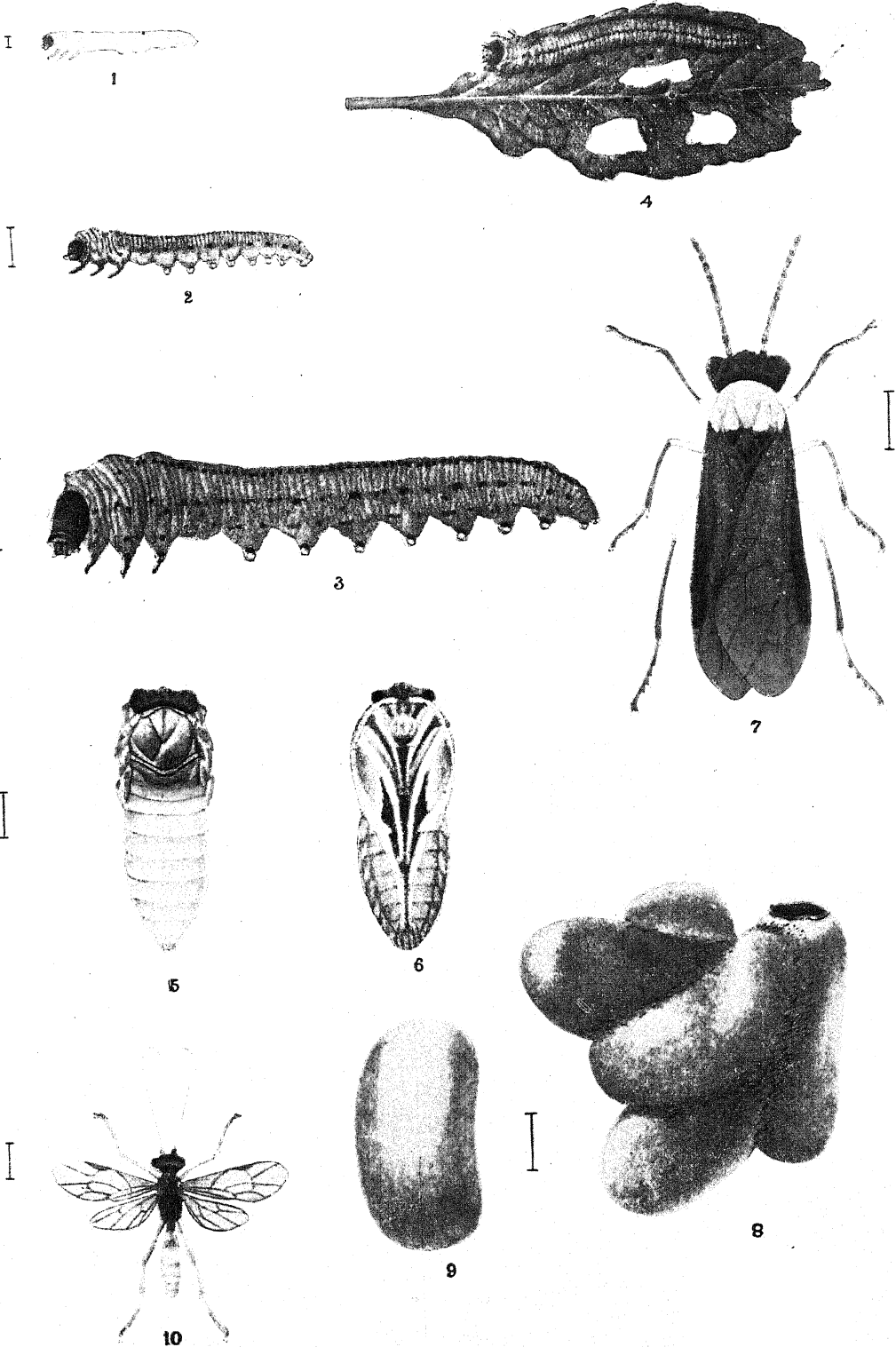
NATURE OF DAMAGE.—The tiny caterpillars of this moth feed on the leaves and pods of til plants. When the plants are young their attack is mainly confined to the top leaves which they web up ; but as soon as the pods are formed, they attack them and eat the seeds. The webbing up of the top leaves generally stunts the growth of the crop.

LOCALITY AND TIME OF APPEARANCE.—This pest probably occurs on til crop everywhere in Bengal.

FOOD-PLANTS.—*Til*.

DESCRIPTION AND LIFE-HISTORY.—It is a small moth of a reddish brown colour (Fig. 10, Plate XXII). The female moths lay eggs at night singly on the leaves of til (Fig. 2, Plate XXII). The eggs hatch in about five days and the tiny caterpillars feed first on the epidermis of the leaves (Fig. 3, Plate XXII). Sometimes they mine into the leaves in this stage. With growth their habit changes ; when four or five days old the caterpillars move up to the top shoots and web up the leaves into a knotty mass (Fig. 6, Plate XXII) ; it then lives inside it feeding on the leaves. When the crop is mature and pods are formed, the caterpillars bore into them and eat the seeds. A full-grown caterpillar is about one-half of an inch in length, and of a green colour with small black dots all over the body (Fig. 4, Plate XXII). When full-fed it comes out of the webbed mass or pods and pupates on leaves under a very fine mesh of silk (Fig. 8, Plate XXII). Moth comes out of it in due course of time.

REMEDY.—The webbed up leaves should be picked off and burnt. If this is done in time, the moths will not be given an opportunity of coming out late in the season to attack the pods. No stray *til* plants should be allowed to grow as they help the pest to keep alive after the main crop has been harvested elsewhere.



MUSTARD SAW-FLY.

Figs. 1, 2, 3, 4.—Larvæ. Figs. 5 & 6.—Pupæ. Fig. 7.—Full-grown saw-fly. Figs. 8 & 9.—Cocoon.
 Fig. 10.—A Parasite.

N. B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

III.—OIL SEEDS.

HOST : C. MUSTARD—*Brassica juncea* and *B. napus*.

VERN. NAMES.—Beng.—*Rai, Sorshe*; Hindi—*Rai, Lúhí, Tori*; Oriya—*Rai, Sorisa*.

PEST—

(a) LEAF-EATING—

MUSTARD SAWFLY.—*Athalia proxima*, Klug.

VERN. NAMES.—*Kalo mehri*—W. Bengal.

NATURE OF DAMAGE.—The grubs of this sawfly feed on the leaves of mustard and many other cruciferous plants.

LOCALITY AND TIME OF APPEARANCE.—Though reported from Bhagalpur, Shahabad and Purnea, it is apparently common all over Behar. It is distinctly a cold weather pest and its period of activity is from October to March.

FOOD-PLANTS.—Mustard, cabbage, radish, field and garden cruciferous plants in general.

DESCRIPTION AND LIFE-HISTORY.—The adult sawfly has a short thick set body marked in black and orange with two pairs of dark coloured wings (Fig. 7, Plate XXIII). They are not good fliers and are generally seen to flit about from plant to plant in the field. They are active only during the day time. The margin of a leaf is slit open by the female fly and eggs are laid in the tissues singly. Many eggs may be laid in one leaf. In about a week the young grubs come out and begin to feed on the leaves, from the edge inwards (Fig. 4, Plate XXIII). They generally feed on the leaves in the mornings and evenings descending to the ground at midday. A young grub is greenish grey and hairless, but as it grows older its colour gradually turns black (Figs. 1-3, Plate XXIII). It goes on feeding on leaves for about a fortnight till it becomes full grown when it measures about two-thirds of an inch. When full-fed it descends to the surface of the ground and pupates there in an earthen cell (Figs. 5-6, Plate XXIII). The adult winged insect comes out of the pupa in about ten to twelve days.

REMEDY.—This pest is rarely destructive when a large area of cruciferous crop is grown, but in small areas it causes heavy loss. A good dusting with lime or road dust mixed with kerosine, will check this pest.

The black colour of the young grubs makes them readily noticeable ; they should be collected and destroyed either by burying or placing them in a tin containing water and some kerosine oil.

References.—Mem. D. Ag. I. (Ent. Series), Vol. I, No. 6. The Mustard Sawfly.
By H. M. Lefroy and C. C. Ghosh.
I. I. P., p. 152.

III.—OIL SEEDS.

HOST : C. MUSTARD—*Brassica juncea* and *B. napus*.

VERN. NAMES—Beng.—*Rai, Sorisha* ; Hindi—*Rai, Lâhi, Tori* ;
Oriya—*Rai, Sorisa*.

PEST—

(a) LEAF-EATING—

DIAMOND BACK MOTH—*Plutella maculipennis*, Curt.

NATURE OF DAMAGE.—The little green caterpillars of this tiny moth eat out holes in the leaves of mustard and other cruciferous plants. The leaves present a withered appearance and in some cases they are eaten up almost completely.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Cuttack and Sabour. The insect is active all through the cold weather.

FOOD-PLANTS.—Cabbage, rape, mustard, etc, and most cultivated cruciferous plants.

DESCRIPTION AND LIFE-HISTORY.—It is a small moth about one-half of an inch long and of a brownish grey colour (Fig. 4, Plate XLV). The inner edges of the forewings are light coloured and this causes characteristic diamond-shaped marks to appear on the back when the wings are folded. The moth is very common in an attacked field and can be seen flying from plant to plant or resting on the leaves during the day. The female moths lay small white eggs at night on the undersurface of the leaves (Fig. 1, Plate XLV). In about a week the caterpillars come out and feed at first on the epidermis of the leaves and in a few days eat out holes in them (Fig. 2, Plate XLV). A full-grown caterpillar is one-half of an inch in length, of a green colour, with the body tapering towards both ends. It becomes full-fed in about a fortnight and then it pupates on the leaf under a fine net of silk (Fig. 3, Plate XLV). The moth comes out of the pupa in about a week. There are usually from eight to twelve broods in a year.

REMEDY.—Spraying either with Crude Oil Emulsion or Lead Chromate is good in case of mustard. Cabbage and other garden vegetables should be sprayed with Tobacco decoction (see Appendix VIII). When spraying is not possible ashes moistened with kerosine may be dusted on the underside of the leaves while they are wet.

Reference.—I. I. P., p. 154.



MUSTARD APHIS.

Fig. 1.—A mustard plant attacked by Aphis, branches on the right hand side slightly and those on the left badly. Fig. 2.—A newly born young Aphis. Fig. 3.—A grown-up wingless female. Fig. 4.—A female which has cast a skin and developed winglobes before passing the final moult and becoming fully winged. Fig. 5.—A fully winged female.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

III.—OIL SEEDS.

HOST : C. MUSTARD—*Brassica juncea* and *B. napus*.

VERN. NAMES.—Beng.—*Rai*, *Sarshe* ; Hindi—*Rai* or *Láhi*, *Tori* ;
Oriya—*Rai*, *Sorisa*.

PEST—

(b) LEAF AND POD-SUCKING—

MUSTARD APHIS.—*Aphis brassicae*, Linn.

VERN. NAMES.—*Jāb*—L. Bengal ; *Láhi*—Behar.

NATURE OF DAMAGE.—The mustard aphis is a serious pest of mustard, rape, *sarson*, etc. They remain in colonies on young shoots, stems and pods and suck the sap out of them with their beaks. An attacked crop ultimately becomes weak and exhausted and does not bear any seed.

LOCALITY AND TIME OF APPEARANCE.—It occurs on mustard all over Bengal. It first appears in small colonies in November, when the plants are young. As its power of reproduction is enormous, it spreads rapidly over big areas.

FOOD-PLANTS.—*Sarson*, *Tori* and cruciferous crops and vegetables.

DESCRIPTION AND LIFE-HISTORY.—These insects are very small, the biggest not exceeding one-tenth of an inch. Each has three pairs of legs and a sucking beak. There are two short tubes projecting from the upper surface of the hind end of the body, known as honey tubes, since they excrete a sweet liquid (Figs. 2, 3, 4, Plate XXIV). On account of the presence of this honey dew, the leaves of an infected plant become sticky and a black fungus grows on them rapidly. There are both winged and wingless species in this class of insects. A small colony of aphis consists mainly of females, which brings forth young ones without the intervention of males. The young ones, in their turn come to maturity very quickly within a few days, and give birth to new generations. So it can be imagined at what an extraordinarily rapid rate their numbers can increase. They generally first appear on a crop in a few small colonies, from which they spread over a big area in a very short time. The winged females (Fig. 5, Plate XXIV) fly from plant to plant and thus their spread is accomplished. These insects thrive best in damp weather or when a moist wind is blowing. Dry hot winds kill them. A vigorous and healthy plant is less liable to attack than a weak one. Crops growing under bad conditions, *i.e.*, with too much moisture or on an exhausted soil, suffer far more than the same plants growing under favourable conditions.

ENEMIES.—Aphis has a large number of enemies. The Ladybird beetle feeds on them greedily. Aphis forms the main food of the young ones of Chrysopa and Syrphus flies.

REMEDY.—Spraying with Crude Oil Emulsion (see Appendix No. IV) in time, is the best and the only remedy. Spraying should be done early, *i.e.*, when there are only a few colonies of them. If they are allowed to spread over big areas it is impossible to check them.

Reference.—I. I. P., pp. 155 & 239.

III.—OIL SEEDS.

HOST : C. MUSTARD—*Brassica juncea* and *B. napus*.

VERN. NAMES.—Beng.—*Rai, Sorshe* ; Hindi—*Rai* or *Lāh Tori* ;
Oriya—*Rai, Sorisa*.

PEST—

(c) FLOWER & POD-EATING—

CABBAGE CATERPILLAR.—*Crocidolomia binotalis*, Zell.

VERN. NAME.—*Mehri*—Bankura.

NATURE OF DAMAGE.—The caterpillars of this moth web up the leaves of mustard plants and live inside the knotted mass. The greatest damage is done when the crop flowers and the pods form. At this time they live inside the webbed masses of flowers and pods and feed on the flowers.

LOCALITY AND TIME OF APPEARANCE.—It is a serious pest of mustard in Bankura District. It generally appears in November and December.

FOOD-PLANTS.—Mustard, cabbage and other cruciferous plants.

DESCRIPTION AND LIFE-HISTORY.—It is a light reddish-brown moth of small size. The female moth lays eggs on the leaves. The caterpillars feed on the epidermis of leaves for the first few days after hatching. An attacked leaf looks white and membranous. After the first few days a caterpillar webs up several leaves together and lives inside it feeding on them. When there are flowers, these are also webbed up along with the leaves and eaten in the same way. A full-grown caterpillar is three-fourth of an inch in length and of a green colour. When full-fed it pupates inside the webbed mass and comes out as a moth in due course of time.

REMEDY.—The webbed up masses are prominent and easy to find in an attacked area. They should be picked off and burnt or otherwise destroyed.

III.—OIL SEEDS.

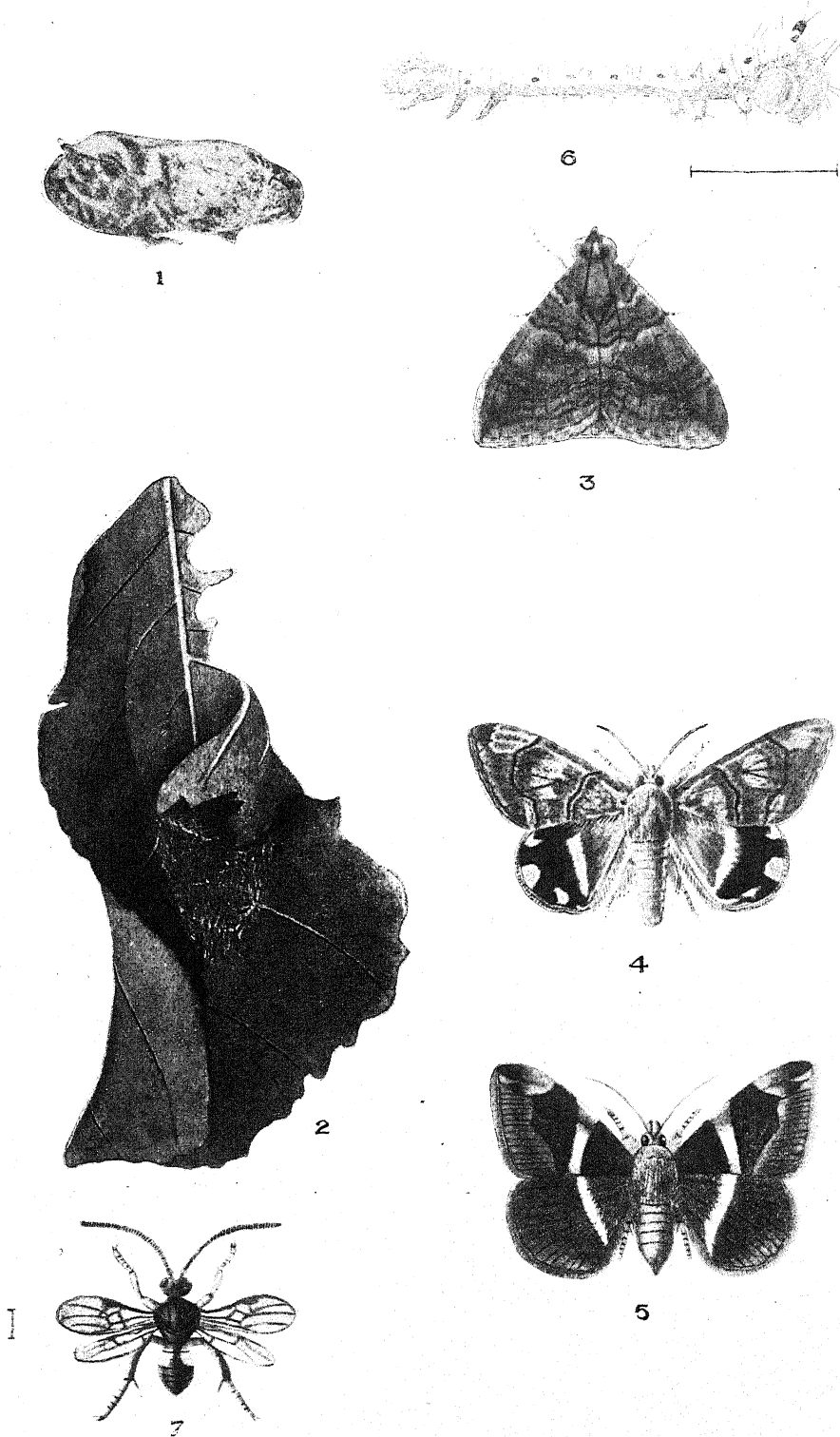
HOST : C. MUSTARD—*Brassica juncea*.VERN. NAMES.—Beng.—*Rai* ; Behari—*Rai* ; Oriya—*Rai*.

PEST—

FUNGUS —LEAF SPOT.—*Polydesmus Erituosus*, Kuhn.

DESCRIPTION.—This disease is also known by the name of *Alternaria brassica* Berk., and it attacks not only mustard but several other cultivated species of the same family such as cabbage, cauliflower, kohl-rabi, turnip and rape. The disease appears somewhat late in the season and its virulence and the consequent damage depend much upon the weather conditions. The disease is recognized by the first appearance of numerous black more or less circular spots on the leaves, stems, and even the pods of the mustard. These spots gradually expand and assume larger dimensions when their centres become somewhat pale in colour. The spores of the fungus appear within the spots and are produced in large quantities ; these are easily blown away by the wind and deposited on healthy plants thus spreading the disease.

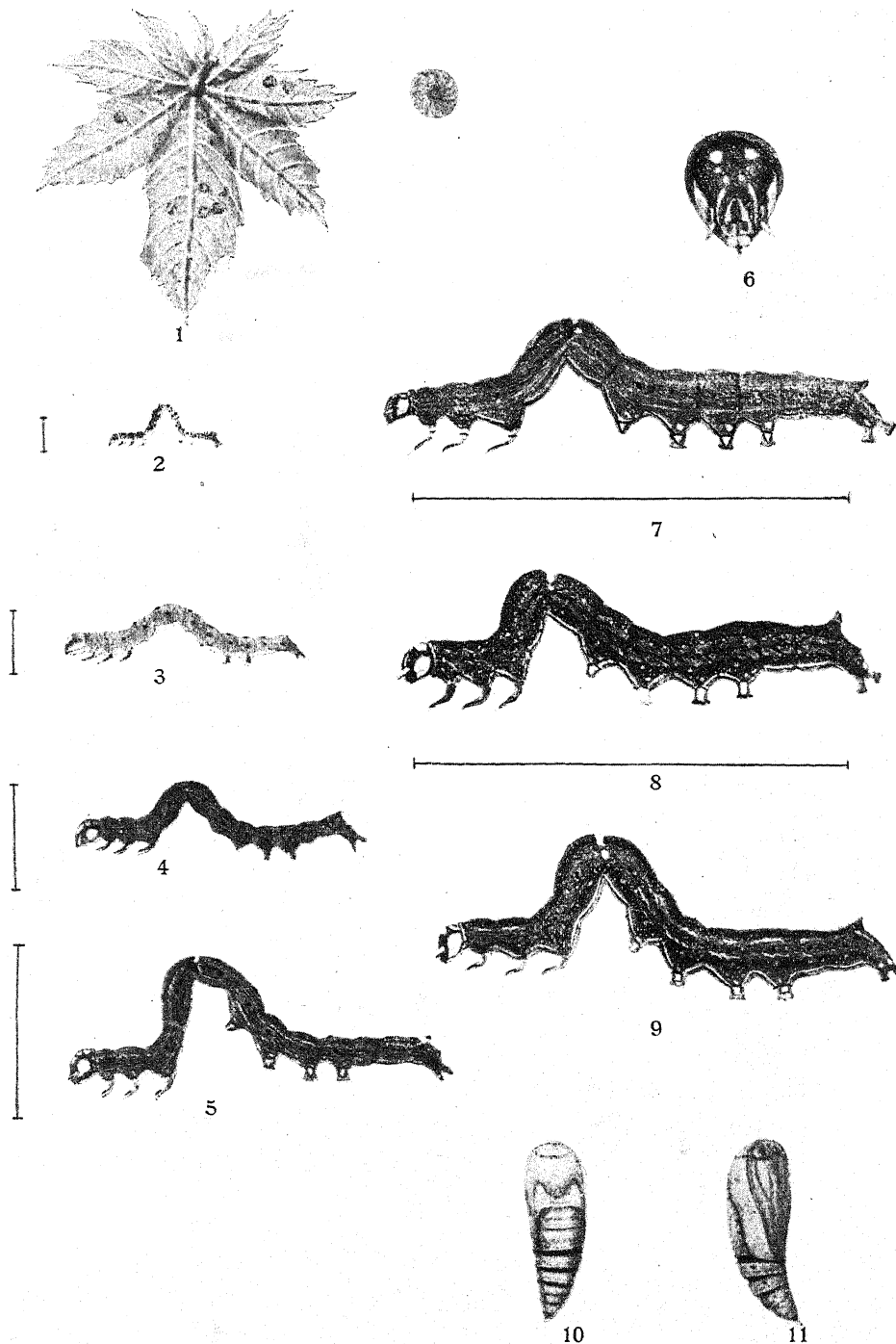
REMEDY.—Usually no treatment seems to be necessary. In severe cases, where possible, Bordeaux mixture (*vide* Appendix No. IX) may be tried, but this cannot be used in the case of cabbages and cauliflowers required for table use.



CASTOR SEMILOOPER.

Fig. 1.—Cocoon underground with adhering earth. Fig. 2.—Cocoon inside a rolled leaf. Fig. 3.—Moth while sitting. Figs. 4 & 5.—Moths set. Fig. 6.—Dying caterpillar clasp parasite cocoon. Fig. 7.—A parasite.

N. B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.



CASTOR SEMILOOPER.

Fig. 1.—Eggs on the leaf with one egg on the right. Fig. 2.—Caterpillar one-day old. Fig. 3.—Caterpillar second stage. Fig. 4.—Caterpillar third stage. Fig. 5.—Caterpillar fourth stage. Fig. 6.—Front of head of a full-grown caterpillar. Figs. 7, 8 & 9.—Caterpillar fifth stage, showing variations in colour. Fig. 10.—Pupa seen from above. Fig. 11.—Pupa seen from below.

N.B.—In cases where the insects have been drawn larger than life-size, the hair lines beside them indicate their natural size.

III.—OIL SEEDS.

HOST : D. CASTOR—*Ricinus communis*.VERN. NAMES.—Beng.—*Reṛi* ; Hindi—*Renr*, *Andṛ*, *Renṛī* ; Oriya—*Jarṛ*.

PEST—

(a) LEAF-EATING—

CASTOR SEMI-LOOPER—*Ophiura melicerte*, Dr.

NATURE OF DAMAGE.—The caterpillars of this moth sometimes appear suddenly in vast numbers, and completely defoliate the castor crop, leaving only the bare stems on the ground. They feed voraciously on the leaves of castor and many other wild Euphorbiaceous plants. When the supply of their wild food plants gets exhausted, they come in swarms to the nearest castor field.

LOCALITY AND TIME OF APPEARANCE.—Under favourable circumstances it may occur in any part of Bengal. There are a few reports of heavy attacks in Behar. The pest is of sporadic occurrence ; its chief period of activity is the rainy season from June to October.

FOOD-PLANTS.—Castor, *dudhia* (*Euphorbia pilulifera*) and probably other Euphorbiaceous weeds.

DESCRIPTION AND LIFE-HISTORY.—The moth is stout bodied, and of a fairly large size, with pale reddish brown forewings and black hind wings with white marks on them (Figs. 3, 4, Plate XXV). By day it remains in hiding on the ground among fallen leaves or bushes, etc, and comes out at dusk. A single female moth lays 400—500 eggs. These are laid singly on the underside of leaves and there is generally not more than 5 or 6 eggs on each leaf (Fig. 1, Plate XXVI). On hatching, the small caterpillars feed first on the lower epidermis of the leaves, and later nibble portions of them from the edge inwards. Full-grown caterpillars feed inwards from the edges of the leaves towards the midribs, stripping them entirely in time and very soon leaving nothing of the plants but the bare stalks. The caterpillar is slender and of a dark colour with longitudinal stripes of red and white. In the young stage the colour is more or less green which gradually changes to velvety black (Figs. 2—9, Plate XXVI). It walks with a semi-looping motion, *i.e.*, humps its back into an arch when moving. When full-fed, it comes down to the ground and pupates (Figs. 10-11, Plate XXVI) in the loose soil or among fallen leaves in a flimsy cocoon. Sometimes it pupates between the folds of leaves. In warm weather the pupal stage lasts from 10 days to a fortnight, after which the moth comes out.

It has probably four broods during the rains. Its life-history occupies about four weeks.

ENEMIES.—It has an important parasite (Fig. 7, Plate XXV), which has been observed to keep the pest in check. This parasitic grub lives inside the body of the caterpillar, causing its death in a short time. The dead caterpillars may sometimes be seen attached to the cocoons of the parasitic grubs (Fig. 6, Plate XXV).

REMEDY.—The first small brood must be captured and destroyed; this may be expected at the end of a spell of cold weather or at the time when the dry hot weather gives place to rain.

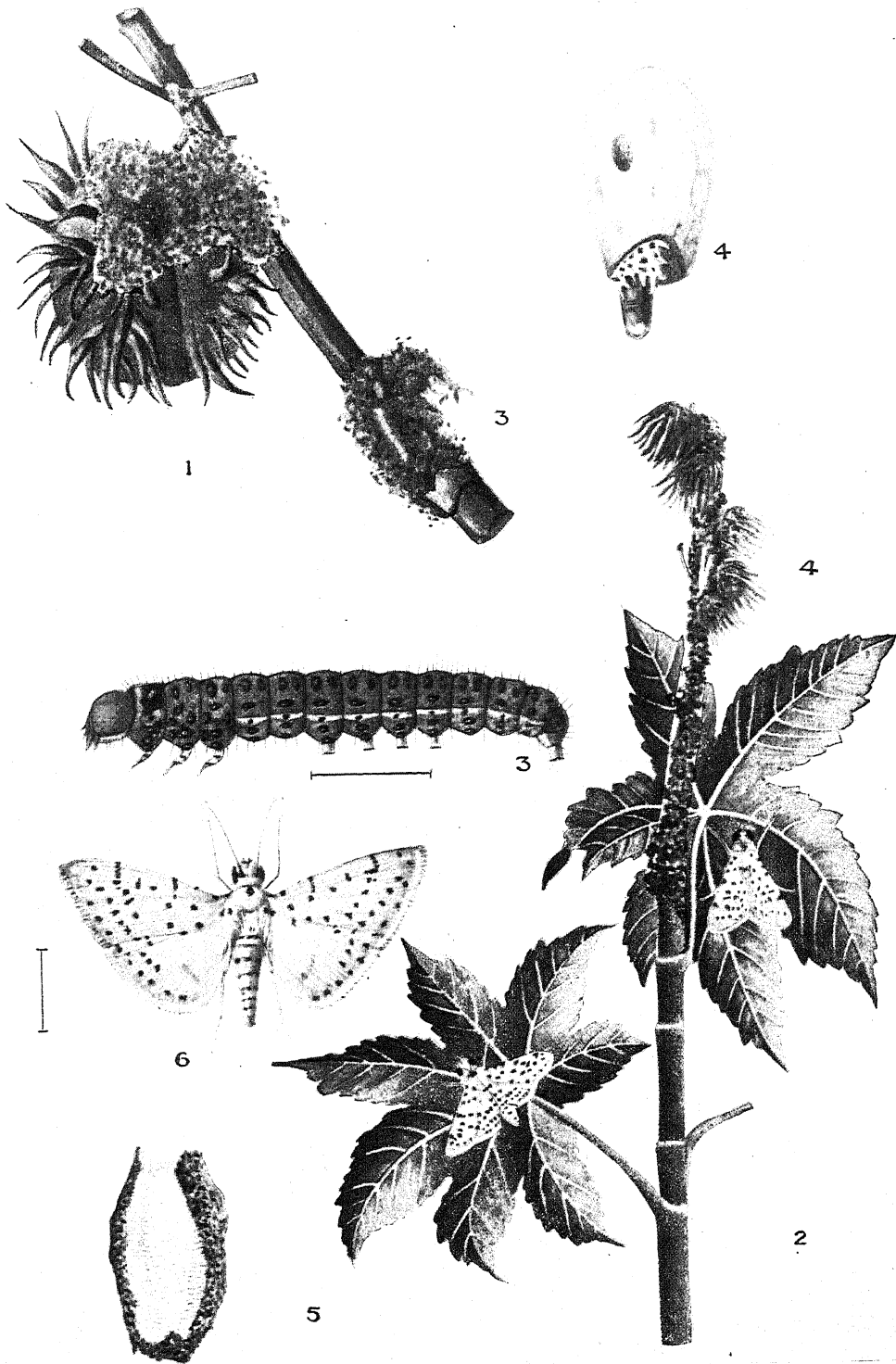
In case of a bad attack, the attacked area should be trenched all round so that the caterpillars may not spread.

Heavy spraying with Lead Chromate is also very useful. (See Appendix No. III.)

The weed *dudhia* should be completely eradicated.

References.—Mem. D. Ag. I., Vol. II, No. 4 (Ent. Series), the Castor Semi-looper by H. M. Lefroy.

I. I. P., p. 138.



CASTOR SEED CATERPILLAR.

Fig. 1—Affected stem and capsule with excrement outside. Fig. 2—Affected topshoot with moth sitting on leaf. Fig. 3—Full-grown caterpillar from the side. Fig. 4—Pupa in castor seed. Fig. 5—Cocoon. Fig. 6—Moth flying.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

III.—OIL SEEDS.

HOST : D. CASTOR.—*Ricinus communis*.VERN. NAMES.—Beng.—*Revi* ; Hindi—*Renr*, *Andī*, *Renrī* ; Oriya—*Jarū*.

PEST—

(b) SEED-EATING—

CASTOR SEED CATERPILLAR.—*Dichocrocis punctiferalis*, Guen.

NATURE OF DAMAGE.—The caterpillars of this moth do some damage to the castor crop by boring into the capsules and eating the seeds. In the absence of capsules they bore into the young shoots and destroy them.

LOCALITY AND TIME OF APPEARANCE.—It is a minor pest of castor and regularly occurs in varying numbers. It generally first appears when the plants are large but the capsules have not formed.

FOOD-PLANTS.—Pods of castor and sun-flower heads.

DESCRIPTION AND LIFE-HISTORY.—It is a small moth of bright yellow colour, speckled with fine black dots on the wings (Fig. 6, Plate XXVII). Eggs are laid by the female moths on the capsules and in their absence on young shoots. A caterpillar on hatching bores either into the capsule or the young shoot, and feeds either on the seeds in the capsules or on the tissues of the shoots. A full-grown caterpillar is about two-thirds of an inch in length and of a pink colour (Fig. 3, Plate XXVII). Its presence is indicated by a black mass of granular substance, its excreta, on the pod or on the stalk or else a long mass of it at the tip of a shoot (Figs. 1, 2, Plate XXVII). When full fed, it pupates inside in a white silken cocoon (Fig. 5, Plate XXVII), from which it comes out as a moth to infect fresh capsules.

REMEDY.—The early attacked capsules should be picked off and burnt or buried. If the shoots are found to be attacked before the capsules form, they should be picked off and destroyed.

No stray castor plant should be allowed to remain anywhere near the castor field as such plants help the pest to breed and multiply.

Reference.—I. I. P., p. 159.

III.—OIL SEEDS

HOST: D. CASTOR.—*Ricinus communis*.VERN. NAMES.—Beng.—*Reri*; Hindi—*Roor*, *Andi*, *R. net* Orisa—*Jirā*.

PEST—

(c) LEAF-SUCKING—

CASTOR MEALY WING.—*Alurodes (ricini)*.

NATURE OF DAMAGE.—The young ones of this mealy wing suck the sap out of the castor leaves with their beaks. The affected leaves curl up and wither.

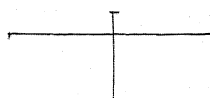
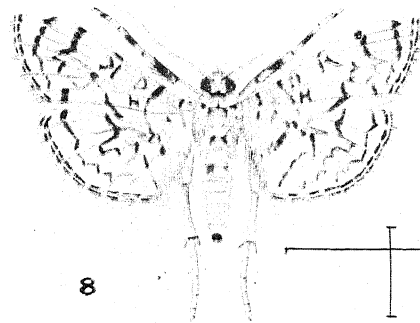
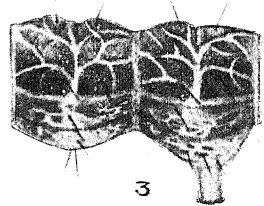
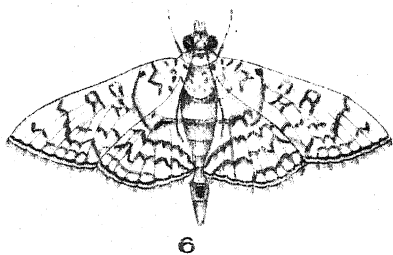
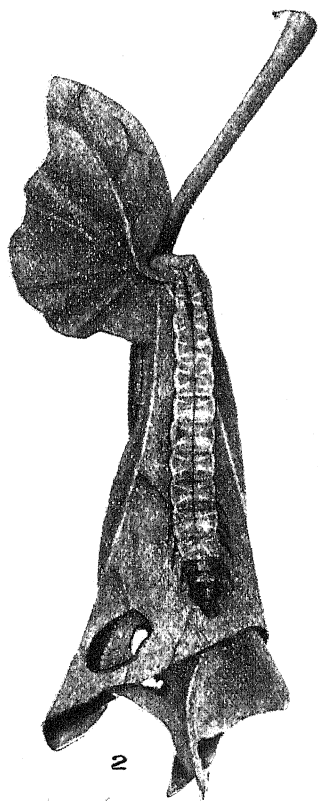
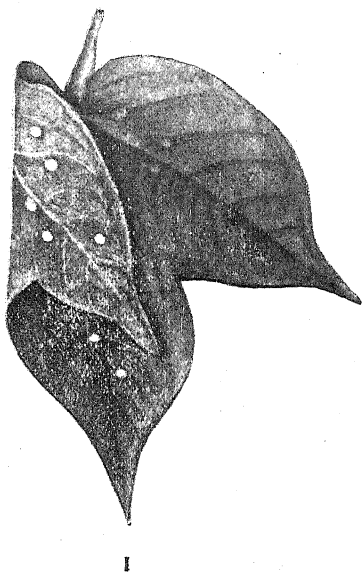
LOCALITY AND TIME OF APPEARANCE.—It is rather common in Behar and probably does occur in other parts of Bengal.

FOOD-PLANTS.—Castor.

DESCRIPTION AND LIFE-HISTORY.—It is a very small insect with yellow body and two pairs of flouy wings. Very minute, oval-shaped eggs are laid in clusters by the female insects on the leaves. The young ones, on hatching, are active for some time and moves about on the leaf till they find out some suitable place to establish themselves permanently. A young insect is very minute, scarcely visible to the naked eye with a flat oval yellow body: in this stage it has no wings. It pushes its beak into the tissues of the leaf and suck the juice out. Once thus settled down it remains until it emerges as a flying insect. They look more or less like small yellow scales attached to the leaf. When full fed, it pupates in the same position. Mature insects with wings emerge in time, fly over to fresh plants and infect them.

REMEDY.—If the insects have not yet attained the flying stage, they may easily be destroyed by cutting off and burning the infested leaves of the plant.

Spraying with Crude Oil emulsion is simple and at the same time very effective. (See Appendix No. IV.)



COTTON LEAF ROLLER.

Fig. 1.—Eggs on leaf. Fig. 2.—Rolled up leaf with caterpillar on it. Fig. 3.—Two segments of caterpillar—magnified. Fig. 4.—Chrysalis as seen from above. Fig. 5.—Chrysalis as seen from below. Fig. 6.—Moth while sitting. Fig. 7.—Hibernating caterpillar. Fig. 8.—Moth as seen flying. N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

IV.—FIBRES.

HOST : A. COTTON.—*Gossypium* spp.

VERN. NAMES.—Beng.—*Kāpās, Tulā*; Hindi—*Kapas, Bangu*; Oriya—*Tula lappa, Tura kappā*.

PESTS—

(b) LEAF-ROLLING—

COTTON LEAF ROLLER.—*Sylepta derogata*, F.

VERN. NAME.—*Choongi pokā*—L. Bengal.

NATURE OF DAMAGE.—The caterpillars of this moth roll up the leaves of cotton plants, live inside the roll and feed on the leaf. In cases of young plants, growth is somewhat checked and in old plants the stripping of leaves results in a decreased yield.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Cuttack and is of frequent occurrence in Behar. The usual period of its activity is July to November after which it hibernates as full-grown caterpillar.

FOOD-PLANTS.—Cotton, ladies' fingers (*bhindi*), hollyhock.

DESCRIPTION AND LIFE-HISTORY.—The moth measures about an inch and a half across the wings. It is of a whitish colour with a faint yellow tinge. There are many fine dark lines, forming an irregular pattern on the wings (Figs. 6, 8, Plate XXVIII). Eggs are laid by the female moths at night singly, and on the lower surface of the leaves or on shoots of young plants (Fig. 1, Plate XXVIII). Each moth lays from 250 to 300 eggs. They hatch within four days and the young caterpillar spends the first few days feeding on the epidermis of the back of the leaf on which it hatched. Then it rolls up the leaf in the form of a funnel, lives inside it, and feeds on the portion of the leaf outside of the roll (Fig. 2, Plate XXVIII). It becomes full-grown in two to three weeks when it measures about an inch. It is slender with a transparent body of a greenish tint, and the darker contents of the alimentary canal shows clearly through the skin. When full-fed, it pupates either inside the roll among the cross threads or it comes down and does so on the ground under fallen leaves (Figs. 4, 5, Plate XXVIII). The moth comes out of the pupa within a week or ten days. At the approach of winter a full-fed larva hides under some sort of shelter and rests in the larval condition through the whole season.

American and Egyptian cottons have been found more susceptible to its attack than the indigenous ones.

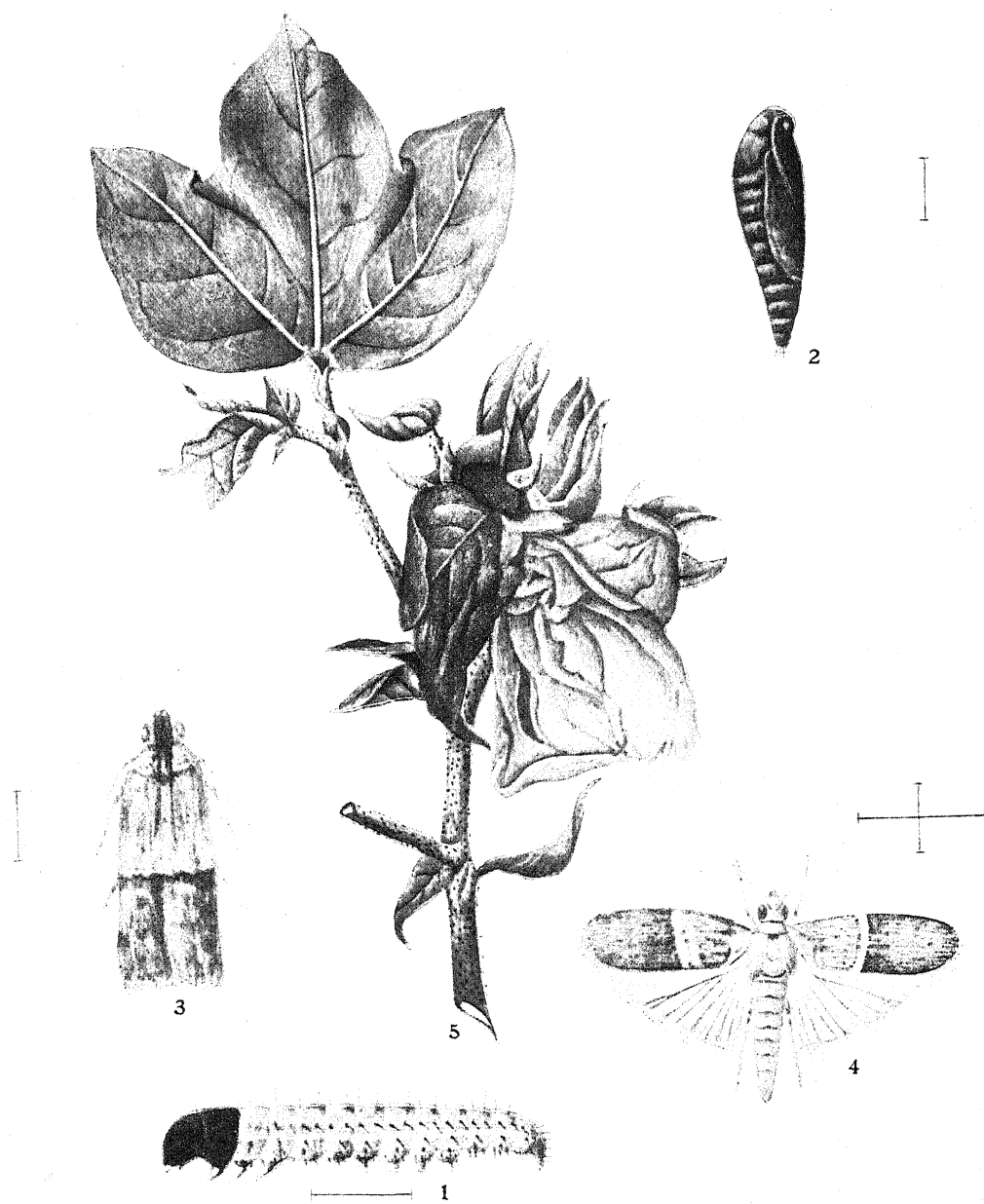
ENEMIES.—The caterpillar has a great enemy in the form of a small parasitic insect of the Bee class, which checks the increase of the pest considerably at times.

REMEDY.—Every rolled-up leaf should be picked off and destroyed with the caterpillar in it. Instead of destroying them they may also be placed in boxes covered with wire gauze, so that the moths on emergence may not escape, whereas the smaller parasites may easily make their way out and attack fresh caterpillars (see Appendix No. VII).

Spraying with Lead Arseniate or Chromate is a good remedy. (See Appendix No. III).

References.—I. I. P., pp. 96-97.

Mem. D. Ag. I., Vol. II, No. 6 (Ent. Series). The Cotton Leaf Roller by H. M. Lefroy.



COTTON BUD MOTH.

Fig. 1.—Caterpillar. Fig. 2.—Pupa as seen from the side. Fig. 3.—Moth while sitting. Fig. 4.—Moth as seen flying. Fig. 5.—Top shoot with an affected bud.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

IV.—FIBRES.

HOST : A. COTTON—*Gossypium* spp.

VERN. NAMES.—Beng.—*Kāpās*, *Tulā*; Hindi—*Kāpās*, *Bāngā*; Oriya—*Tula kappa* or *Tura kappa*.

PEST—

(b) LEAF-ROLLING—

COTTON BUD CATERPILLAR.—*Phycita infusella*, Meyr.

NATURE OF DAMAGE.—The caterpillar of this moth damages young cotton plants only. It lives on the top shoots, binding the leaves together into a compact knot, which in time dries up and turns brown. No damage is done to the old plants.

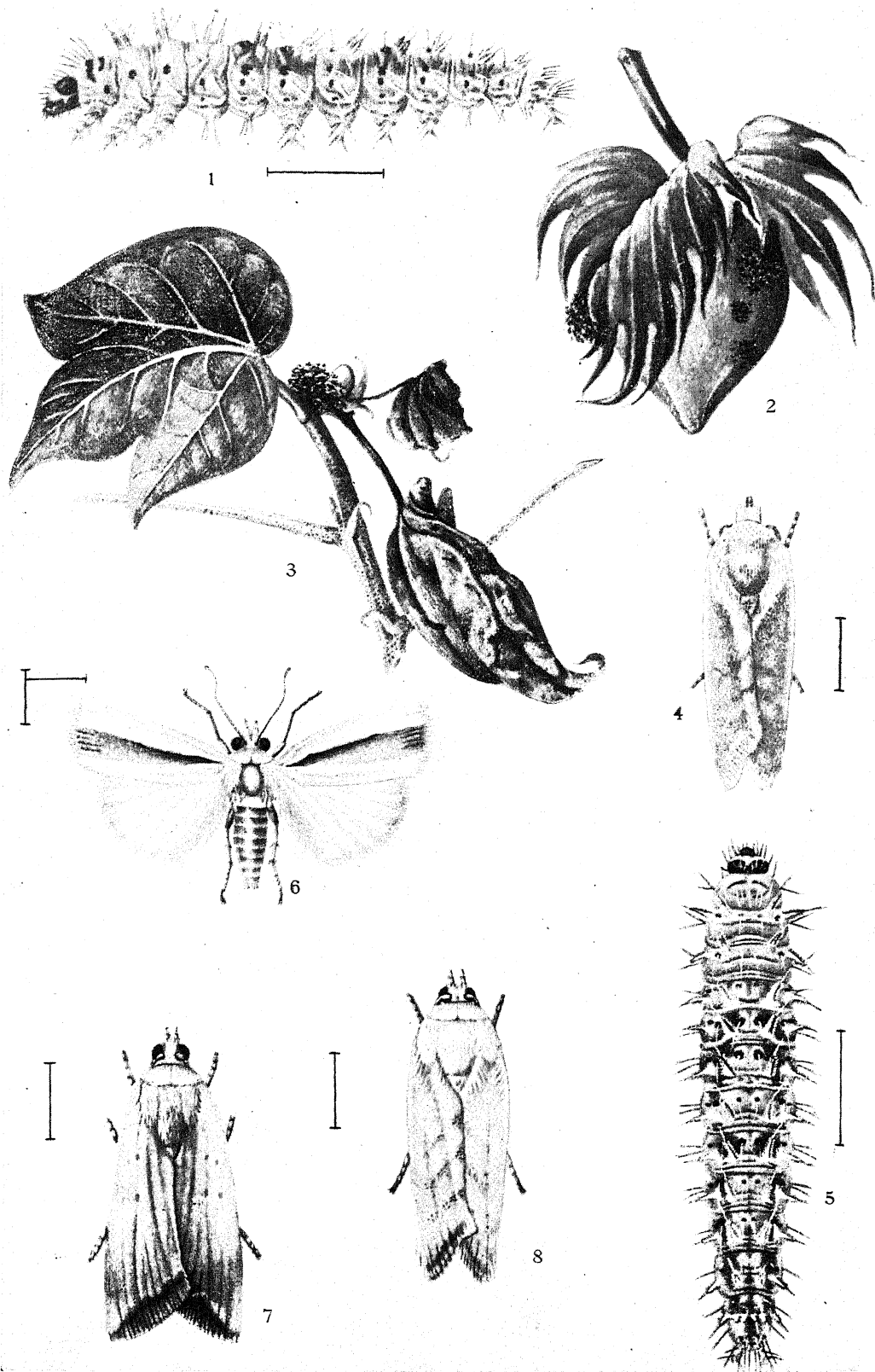
LOCALITY AND TIME OF APPEARANCE.—It has been reported from Cuttack. Its attack generally occurs in July, August and September.

FOOD-PLANTS.—Cotton.

DESCRIPTION AND LIFE-HISTORY.—The moth is small, less than one-half inch in length, with the basal half of the forewing grey and the apical half dark (Figs. 3, 4, Plate XXIX). It flies about the fields at dusk and lays eggs on the top shoots. The caterpillars on hatching feed on the buds and young leaves at the tip of the shoots and web these together into a knotty mass (Fig. 5, Plate XXIX). When full-grown, a caterpillar is about two-thirds of an inch in length of a green colour with fine waved brown stripes along its back (Fig. 1, Plate XXIX). When full-fed, it pupates (Fig. 2, Plate XXIX) within the twisted leaves and comes out as a moth in due course.

REMEDY.—The dried-up or webbed knots of leaves, with the caterpillar or pupa inside them, should be picked off and burnt or otherwise destroyed.

Reference.—I. I. P., pp. 99-100.



COTTON BOLL-WORM.

Fig. 1.—The boll-worm. Fig. 2.—An attacked boll, showing the black mass of excreta thrown out. Fig. 3.—An attacked shoot, with a worm inside it. Fig. 4.—A moth with closed wings. Fig. 5.—Another view of the worm. Figs. 6, 8.—The moths. Fig. 7.—The moth of a similar but distinct species which does not attack cotton.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

IV.—FIBRES.

HOST: A. COTTON—*Gossypium* spp.

VERN. NAMES.—Beng.—*Kāpās*, *Tulā*: Hindi—*Kāpās*, *Bāngī*: Oriya—*Tula kappa*, *Tura kappa*.

PEST—

(c) BOLL-EATING—

GREEN BOLL WORM.—*Earias insulana*. Boisd.

SPOTTED BOLL WORM.—*Earias jabia*, Stoll.

VERN. NAME.—*Gutir pokā*—L. Bengal.

NATURE OF DAMAGE.—The caterpillars of this moth bore into the ripening bolls of cotton and feed on the seeds. The lint is thus destroyed and the bolls drop off if they are small.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Cuttack and Bankipore. Its attack begins with the rains. Where cotton is grown throughout the year, it is continually attacked except in the cold weather.

FOOD-PLANTS.—Cotton, ladies' fingers (*bhindi*) and malvaceous weeds.

DESCRIPTION AND LIFE-HISTORY.—Both these moths are small and measure about one-half of an inch. The forewings are green or white with a green band; sometimes they are buff-coloured (Figs. 4, 6, 8, Plate XXX). The hind wings are white. Small eggs are laid by the female moth on bolls, bracts or terminal leaves of cotton plants and these generally hatch in four or five days. The dark-coloured caterpillars on emergence bore into the bolls if they have formed already or in their absence they bore into the shoots and destroy them (Figs. 2, 3, Plate XXX). When they attack bolls, they penetrate into the seeds and cut the lint on their way. They become full-grown after feeding inside a boll for about a fortnight when they measure about two-thirds of an inch, having a patchy colour made up of a mixture of white, green, black and orange (Figs. 1 & 5, Plate XXX); the middle of the body is thicker than the ends. A full-fed caterpillar comes out of the boll and pupates in a rough grey cocoon formed either on the plant or in the soil. The moth comes out in ten or twelve days. The shortest total life-history lasts about a month. The moths fly about at dusk but are not attracted by light.

REMEDY.—The first brood of boll worms generally attack shoots and early bolls. The attacked shoots are readily recognised by their withered and drooping appearance.

These should be picked off and burnt or buried deeply under ground. The destruction of shoots and bolls at an early stage of attack is the most simple and effective remedy.

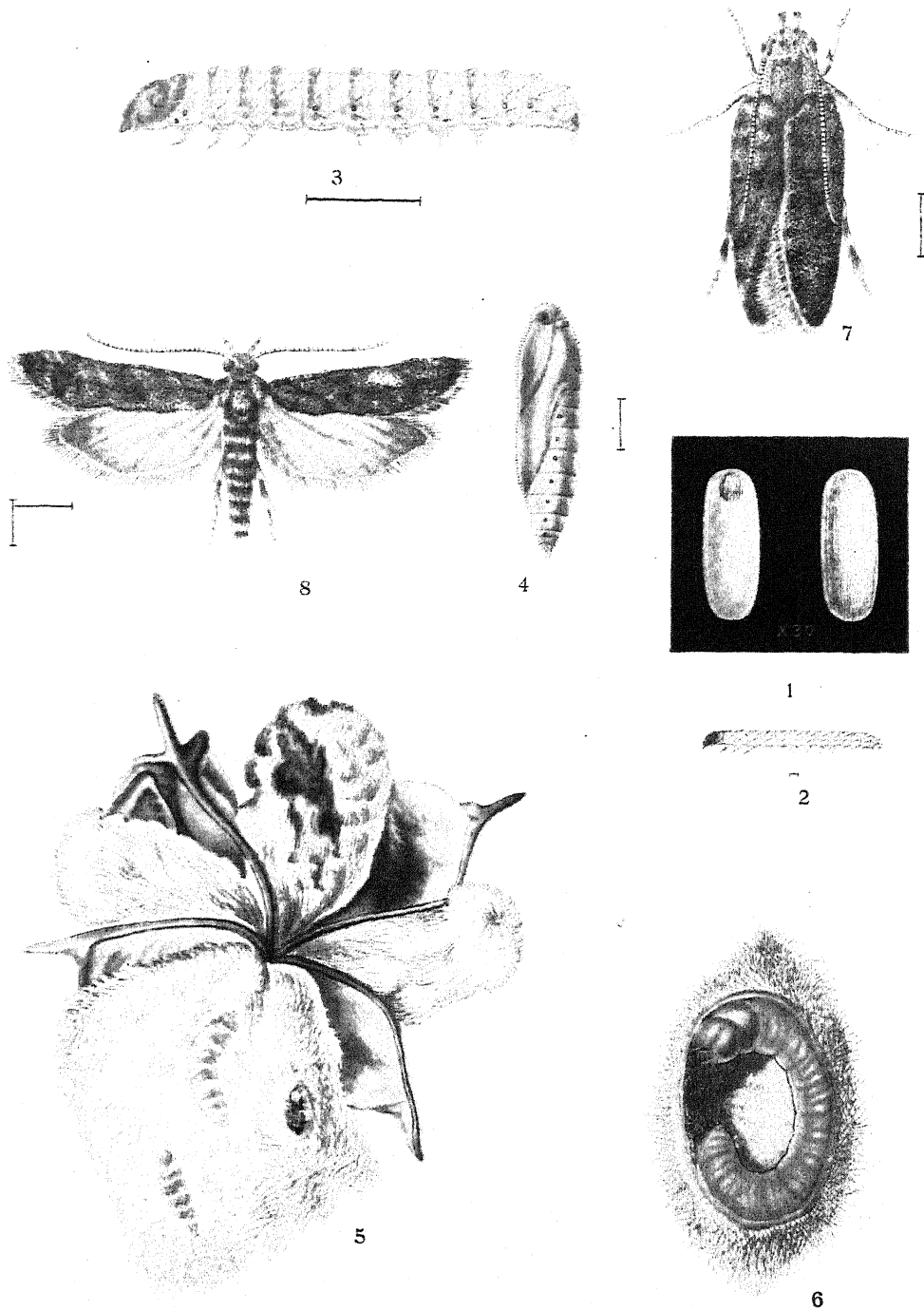
Old cotton plants should not be allowed to stand in the fields after the crop has been picked and old cotton fields should be ploughed up to kill the pupæ in soil.

Ladies' fingers may be grown with the cotton as a trap crop. The pest will first attack the ladies' fingers and the attacked fruits should be continually picked off to prevent the pest spreading to the cotton. In places where cotton is much grown ladies' fingers should not be grown near the cotton fields when the cotton is out of the ground, as the pest can then propagate itself and is always ready to attack the cotton plants when they appear.

References.—Bull. D. Ag. I., No. 2, January, 1906. An Outbreak of Cotton Pests in Punjab, 1905.

A. J. I., Vol. I, The Insect Pests of Cotton in India, by H. M. Lefroy, p. 49.

I. I. P., pp. 91-92.



PINK BOLL WORM.

Fig. 1.—Eggs—magnified. Fig. 2.—Newly hatched caterpillar. Fig. 3.—A full-grown caterpillar—magnified. Fig. 4.—Pupa. Fig. 5.—An affected open boll showing caterpillar and pupa in the lint and also a seed in which there is a hibernating larva. Fig. 6.—Seed cut open to show hibernating larva. Fig. 7.—Moth while sitting. Fig. 8.—Moth as seen flying.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

IV.—FIBRES.

HOST : A. COTTON—*Gossypium* spp.

VERN. NAMES.—Beng.—*Kāpās*, *Tulā* ; Hindi—*Kapās*, *Bāngū* : Oriya—*Tula kappa*, *Tura kappa*.

PEST—

(c) BOLL-EATING—

PINK BOLL WORM.—*Gelechia gossypiella*, Saund.

NATURE OF DAMAGE.—The caterpillars of this moth attack both green and ripe cotton bolls and feed on the seeds.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Cuttack. It is most abundant when the cotton plants form bolls in September and October. In Behar, it generally lives through the cold weather in the lint or seed inside the boll and comes out as a moth in April. Its period of activity begins with the rains.

FOOD-PLANT.—Cotton.

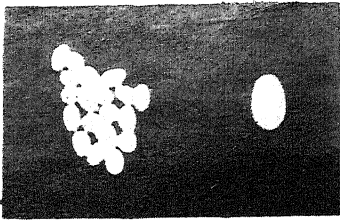
DESCRIPTION AND LIFE-HISTORY.—It is a small grey-coloured moth less than one-half of an inch in length, with long brown fringes on the wings (Figs. 7, 8, Plate XXXI). It flies about at night and is attracted by light. A female moth lays a number of eggs singly on leaves, stalks and bolls. A young caterpillar first feeds for a few days on leaves and then bores into the boll and eats the oily seeds (Fig. 5, Plate XXXI). When young, its colour is white, but as it grows old, pink blotches appear on the body. It takes from two to four weeks to become full-grown, when it measures two-thirds of an inch (Fig. 3, Plate XXXI). When full-fed, it pupates inside the boll in a silken cocoon (Fig. 5, Plate XXXI). The moth emerges in fifteen to twenty days.

REMEDY.—The early brood of this pest should be checked by plucking off the first crop of affected bolls and destroying them so that there might not be a larger second brood to cause serious damage.

Since the caterpillars pass the winter in the seeds, they should be fumigated. The seeds which are to be stored for the next year should first be pickled in a paste of cowdung and mud and then dried in a cool place ; when completely dry, they should be thrown in a bucketful of water. The affected seeds will float while the healthy ones sink. These healthy seeds only should be taken out, dried and stored for next year's seed purposes.

References.—I. I. P., pp. 93—96.

A. J. I., Vol. I. The Insect Pests of Cotton in India, by H. M. Lefroy, pp. 49—62.



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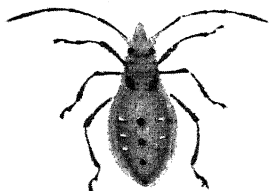
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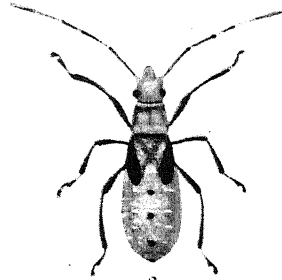


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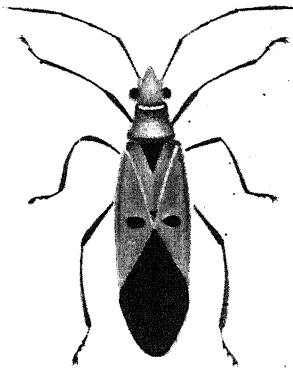
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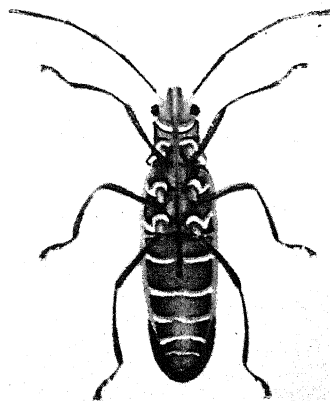
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RED COTTON BUG.

Fig. 1—Eggs in a cluster, an egg to the right of the cluster enlarged six times. Fig. 2—Nymphs after emergence. Fig. 3—Nymph second stage. Fig. 4—Nymph third stage. Fig. 5—Nymph fourth stage. Fig. 6—Nymph fifth stage. Fig. 7—Adult bug as seen from above. Fig. 8—Adult bug as seen from below.

IV.—FIBRES.

HOST : A. COTTON—*Gossypium* spp.VERN. NAMES.—Beng.—*Kāpās*, *Tulā* ; Hindi—*Kapās*. *Bāqū* ; Oriya—*Tulā kappā*, *Turā kappā*.

PEST—

(d) SUCKING :—

RED COTTON BUG.—*Dysdercus cingulatus*, Fabr.VERN. NAMES.—*Kāpāsī pokā*, *Jhāqū pokā*, L. Bengal : *Kāpā pokā*. Orissa.

NATURE OF DAMAGE.—This bug sucks out the juice from the seed of either green or ripe cotton bolls with its narrow long beak both in its young and adult stages. When the insects are abundant, a large quantity of seed is thus destroyed and the lint also gets stained by their excreta.

LOCALITY AND TIME OF APPEARANCE.—It has been reported only from Jamtara in the Sonthal Pergannas, but it occurs everywhere in Bengal where cotton is grown. It increases rapidly in warm weather and when there is an abundance of food. Reproduction practically ceases when there is a scarcity of it. It is a major pest of cotton and of general and regular occurrence. Though it does not do heavy damage in any one locality, the aggregate loss on account of it is great.

FOOD-PLANTS.—Cotton, ladies' fingers, hollyhock, silk cotton, etc.

DESCRIPTION AND LIFE-HISTORY.—A full-grown insect is of a red colour with the tips of the wings black and a black dot on each wing, and measures a little over one half of an inch (Figs. 7, 8, Plate XXXII). It has a red body with white bands across it, and is provided with long beak-like mouthparts with which it sucks liquid food. Eggs are laid in clusters on the ground by the female bugs and covered up by loose earth (Fig. 1, Plate XXXII) ; each cluster containing 70—80 eggs. Within a week these hatch and small active red bugs come out. These resemble the adults, except that they are smaller in size and have no wings, which develop gradually with the growth of the insect (Figs. 2—6, Plate XXXII). They may be found clustered together in large numbers on bolls sucking the juice of the seeds by puncturing the bolls with their beaks. A young bug becomes an adult without passing through a resting stage.

REMEDY.—Hand-picking is a very effective and at the same time very easy method. A cooly should go through an attacked field with a kerosine tin containing

some kerosine oil and water and a grain winnow in his hand. By smartly jerking the plant the insects can easily be thrown in the winnow and shaken off into the tin. If this is done carefully, no insect will be left.

The seeds for sowing should be pickled first in a mixture of cowdung and clay, then dried in a cool place. If it is then thrown into a bucketful of water the attacked seeds will float while the sound ones will sink. The sound seeds should then be dried and preserved for seed purposes.

Reference.—A. J. I., Vol. I. The Insect Pests of Cotton in India, by H. M. Lefroy, pp. 49—62.
I. I. P., pp. 104—107.

IV.—FIBRES.

HOST : A. COTTON—*Gossypium* spp.VERN. NAMES.—Beng.—*Kajās, Tulā* ; Hindi—*Kājās, Bānās* ; Oriya—*Tulā kappā, Tura kappā*.

PEST—

(d) SUCKING :—

COTTON APHIS—*Aphis gossypii*, Glover.VERN. NAMES—*Kāpasē, Jāh pōkā*—Bengal.

NATURE OF DAMAGE.—These minute insects are found in colonies sucking the juice out of the leaves and shoots of cotton plants. An attacked crop gets stunted in growth and is unable to produce a full crop of good cotton.

LOCALITY AND TIME OF APPEARANCE.—It may occur on cotton wherever it is grown in Bengal. It appears during the rains and continues till the cold weather. It thrives best under warm moist conditions and in cloudy days.

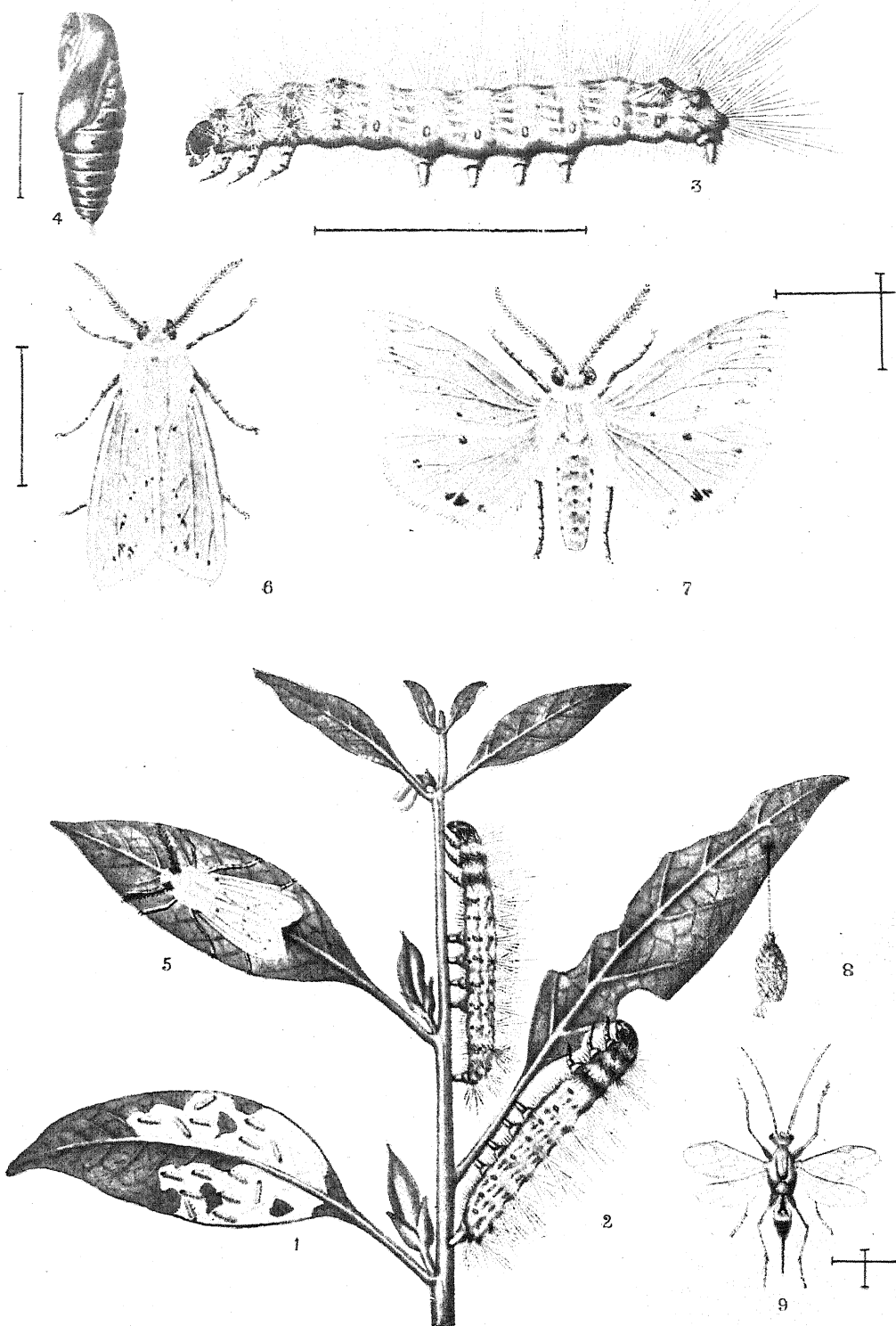
FOOD-PLANTS.—Cotton.

DESCRIPTION AND LIFE-HISTORY.—It is a minute dull yellow or black-coloured insect found in clusters on shoots and leaves of cotton plants, sucking the juice out of them with their small narrow beaks. Most of the members of a colony are females and they bring forth live young ones instead of eggs. These young insects become mature and ready to give birth to another batch of insects in five or six days. In this way they increase enormously in a very short time. They first appear in a few small colonies but when the food-supply gets exhausted, winged females appear and fly over to fresh plants, start fresh colonies and infect fresh areas. The insect has two small tube-like processes on its back through which a sweet liquid oozes out. The fluid gives a sticky coating to the leaves on which it falls.

ENEMIES.—Aphis has a large number of enemies. The young ones of *Chrysopa*, *Syrphus* fly, and both young and adult Ladybird beetles feed on them. These insects should on no account be destroyed.

REMEDY.—Spraying the first colonies with Crude Oil Emulsion (See Appendix No. IV) is the most effective method of checking them. If they are allowed to spread, it becomes very difficult to check them even by spraying.

Reference.—I. I. P., pp. 110-111.



BEHAR HAIRY CATERPILLAR.

Fig. 1.—A leaf with young caterpillar on it. Fig. 2.—Full-grown caterpillars. Fig. 3.—A full-grown caterpillar as seen from the side, magnified. Fig. 4.—Pupa, from side. Fig. 5.—Moth sitting on a leaf. Fig. 6.—Moth with wings folded. Fig. 7.—Moth as seen flying. Fig. 8.—Pupa of a parasite. Fig. 9.—Parasite.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

IV.—FIBRES.

HOST : B. JUTE—*Corchorus olitorius*—*Corchorus capsularis*.

VERN. NAMES.—Beng.—*Pāt, Nalita, Koshtā* ; Hindi—*Pātunā, Pāt* ,
Oriya—*Nalita, Jhuta*.

PEST—

(a) LEAF-EATING :—

BEHAR HAIRY CATERPILLAR—*Ditoclisia obliqua*, Wlk.

VERN. NAMES.—*Achā polā*—Calcutta : *Sat polā*—L. Bengal : *Buchā*—
Jessore : *Bhut*—Behar : *Sambhut*—Orissa.

NATURE OF DAMAGE.—The hairy caterpillars of this moth feed on the leaves of jute and many other field crops. In case of a big attack the whole crop is defoliated.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Chinsurah and Dum-Dum attacking jute, and reports have been received from various other places of its attack on other field crops. It is fairly common in Lower Bengal and Behar. The rainy season is its period of greatest activity.

FOOD-PLANTS.—Jute, Pea, *Til*, Sann Hemp, Cotton, *Bajra*, *Juar*, Maize, Linseed, Groundnut, Sunflower, etc.

DESCRIPTION AND LIFE-HISTORY.—It is a pale buff-coloured medium-sized moth with black spots on the wings (Figs. 5—7, Plate XXXIII). The body is crimson with black spots on back and sides. The moths hide away during the day and come out after dark. The female moths lay eggs at night in flat expanses on the lower surface of leaves. Each moth lays from four hundred to one thousand eggs. They hatch in three or four days, and the young caterpillars on emerging begin to feed on the lower epidermis of leaf and skeletonize it (Fig. 1, Plate XXXIII). For the first few days they remain together in large numbers but gradually disperse and spread over the whole area. In two or three weeks the caterpillar becomes full-grown when it measures about an inch and a half and has an orange-coloured body with both ends black (Fig. 2, Plate XXXIII). The whole body is covered with hairs. When full-fed, a caterpillar sheds its hairs and pupates in the soil inside a rough cocoon composed mainly of hair. After about ten days it comes out as a moth and lays eggs. The life-cycle is completed in from four to six weeks.

ENEMIES.—There is a parasite (Fig. 9, Plate XXXIII) of this pest which passes its young stage inside the body of the caterpillars and in course of time kills them.

REMEDY.—Since the caterpillars are gregarious in the young stage and their presence is easily recognised by the skeletonized leaves, these leaves with caterpillars on them should be picked off and thrown into kerosine.

As these caterpillars pupate on the surface of the soil, light cultivation does good if given when they suddenly disappear from the plants.

In cases where a very large area is attacked, the crop may be dusted or sprayed with Lead Arseniate or Lead Chromate (See Appendix No. III), but it is better to collect the young caterpillars when they first appear.

If the caterpillars are found to have been parasitised, they should be collected and put in a box covered with wire gauze with meshes big enough for an ordinary house fly to pass through. They should be provided with green food regularly. The parasitic flies will come out of the box and attack the healthy caterpillars in the field, while the larger moths remain confined in the box.

Where an attack is very heavy and the caterpillars are seen to be moving from one field to another, the affected areas should be trenched round : the caterpillars in their onward motion will then fall into the trenches and be killed if the trenches are kept filled with kerosinised water.

References.—A. J. I., Vol. I, The Hairy Caterpillar Pests of Crops, by H. M. Lefroy, pp. 187—192.
I. I. P., pp. 193-194.



JUTE PESTS.

Fig. 1.—Egg cluster of indigo caterpillar. Fig. 2.—The caterpillar. Fig. 3.—The moth. Fig. 4.—Jute semilooping caterpillar. Fig. 5.—The moth sitting on a leaf. Fig. 6.—Egg cluster of Behar hairy caterpillar. Fig. 7.—Young caterpillars on a leaf. Fig. 8.—Full-grown caterpillar. Fig. 9.—Moth sitting on a leaf. Fig. 10.—Jute Apion. Fig. 11.—Its grub. Fig. 12.—Top shoot withering on account of its injury. Fig. 13.—Leaf withering on account of its injury.

IV.—FIBRES.

HOST : B. JUTE—*Corchorus olitorius*—*Corchorus capsularis*.

VERN. NAMES.—Beng.—*Pāt, Nalita, Koshtā*; Hindi—*Pātāṭ, Pāt*, Oriya—*Nalita, Jhota*.

PEST—

(a) LEAF-EATING :—

JUTE SEMI-LOOPER—*Cosmophila sabulivora*, Guen.

VERN. NAMES.—*Ghorā polāṭ*, Lower Bengal : *Dorāṭ*, 24-Pergannas : *Dorā polāṭ, Jorā polāṭ*, Jessore : *Anchāṭ polāṭ*, Murshidabad ; *Tūchingā, Khulna*.

NATURE OF DAMAGE—The caterpillars of this moth feed on the apical buds and top shoots of jute plants. When an apical bud is destroyed, the plant sends out new side branches which means a shortening of the fibre and a consequent diminution of its price.

LOCALITY AND TIME OF APPEARANCE.—It occurs as a serious sporadic pest on jute in Bengal. It has been reported from Chinsurah, Nadia, Jessore, 24-Pergannas, and Cuttack. It generally appears in June and continues damaging the jute crop till it flowers, *i.e.*, up to August.

FOOD-PLANT.—Jute.

DESCRIPTION AND LIFE-HISTORY.—It is a medium-sized moth of a dull earth brown colour with darker spots and wavy lines on the forewings (Fig. 5, Plate XXXIV). It remains concealed during the day and comes out at dusk to fly freely about the fields. The female moths lay eggs at night singly on the small top leaves, each moth laying about 150—200 eggs. These hatch in about two days and the little green caterpillars on emerging feed on very young leaves and buds. A full-grown caterpillar is about one and a half inches long, of a green colour, with some black dots on it, and it walks with a semi-looping motion, *i.e.*, humps its back into an arch when it moves (Fig. 4, Plate XXXIV). If disturbed while eating, the caterpillar generally jumps off with a jerky motion and crawls up the plant again after some time. In fifteen days it becomes full-fed and comes down to pupate in the soil. The moth comes out in six to nine days. It generally passes the winter as a pupa in the soil.

REMEDY.—Bagging (See Appendix I) is very effective. If a long string be soaked in phenyle, kerosine or turpentine and drawn across one affected field brushing the tops of the plants, the caterpillars generally come down from the top shoots on

account of the strong smell and feed on the lower leaves which does not do so much damage to a luxuriant plant like jute.

Since the pupæ remain in the soil during the winter, the land should be ploughed up and the margins of the plots cleaned immediately after the crop is harvested. This will destroy a large number of pupæ.

A good spraying with Lead Chromate or Lead Arseniate is very effective. (See Appendix No. III.)

Reference.—A. J. I, Vol. II, Insect Pests of Jute, by H. M. Lefroy,
pp. 109—116.

IV.—FIBRES.

HOST : B. JUTE.—*Corechorus olitorius*—*Corechorus capsularis*.

VERN. NAMES.—Beng.—*Pāt*, *Nalita*, *Koshtā* ; Hindi—*Pātūā*, *Pāt* ; Oriya—*Nalita*, *Jhuta*.

PEST—

(a) LEAF-EATING—

INDIGO CATERPILLAR.—*Lapthana eripata*. Guen.

VERN. NAMES.—*Kāthri*. Lower Bengal : *Gore pokā*, Hugbli ; *Berī Horihāri*, Bogra ; *Larkā*, Patna.

NATURE OF DAMAGE.—The caterpillars of this moth feed on the leaves of young jute plants. When concentrated on a small area they defoliate the plants completely leaving only the bare stems on the ground.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Chinsurah and Cuttack. It occurs all over Bengal on jute and other crops. It may be looked for from about the time the seed germinates till the plants are about a foot high.

FOOD-PLANTS.—Jute, Indigo, Lucerne, Lentil, Cabbage, Maize, Safflower, Cotton, etc.

DESCRIPTION AND LIFE-HISTORY.—It is a small moth with dark spotted forewings and white hind wings (Fig. 3, Plate XXXIV). It comes out only after dark. The female moth lays eggs in clusters on young leaves. Each cluster is covered with buff-coloured hairs and may contain from 50—200 eggs (Fig. 1, Plate XXXIV). One moth can lay as many as 250 eggs. These hatch in two or three days and the small green caterpillars on emerging feed on the epidermis of the young leaves for the first few days. Sometimes they web up the top leaves and live and feed inside these during this period. After this they spread and feed on the leaves. The caterpillars generally feed in the morning and afternoon, taking shelter during the hottest part of the day. If disturbed while feeding a caterpillar will curl and drop down from the plant. In about 15 days it becomes full-grown when it measures about an inch (Fig. 2, Plate XXXIV). Its colour is very variable, generally green with reddish or dark spots on the sides. A full-fed caterpillar pupates in the ground under fallen leaves or stones, etc., and comes out as a moth within a week.

ENEMIES.—The Indigo caterpillar has a fly parasite which lives inside its body and kills it in time.

REMEDY.—After the jute seed has germinated, small bonfires should be lighted in the fields for several consecutive nights : the moths, if there be any in the area, will fly to the fire, and be burnt. The prominent egg clusters should be picked off and destroyed. Bagging is also very effective (see Appendix No. I). Since these caterpillars prefer lucerne to jute, it should be taken as a trap crop in jute areas. The first brood on lucerne should then be destroyed.

The moths can be caught at night in a patent trap devised by Messrs. Andres Maire, Egypt, which trap is under experiment in India now.

References.—A. J. I., Vol. I, The Caterpillar Pests of Indigo in Behar, by H. M. Lefroy, pp. 339—351.

A. J. I., Vol. II, Insect Pests of Jute, by H. M. Lefroy, pp. 109—116.

IV.—FIBRES.

HOST : B. JUTE.—*Corchorus olitorius*—*Corchorus capsularis*

VERN. NAMES.—Beng.—*Pat. Nalita, Koshta* : Hindi—*Patur, Pat* . Oriya—*Nalita, Jhuta*.

PEST—

(b) STEM BORING—

JUTE STEM WEEVIL.—*Aphon sp.*

VERN. NAMES.—*Aulá poka, Aulo pokat*—Lower Bengal.

NATURE OF DAMAGE.—The young grubs of this minute weevil feeds on the tissues inside jute stem near the axils of the top leaves. The affected shoots and leaves wither (Figs. 12-13, Plate XXXIV), the length of the fibre is affected and the crop becomes stunted.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Chinsurah and Cuttack. It generally appears in June and July when the plants are small.

FOOD-PLANT.—Jute.

DESCRIPTION AND LIFE-HISTORY.—The adult weevil is very small, of a black colour and with an elongated snout (Fig. 11, Plate XXXIV). The female weevil makes a small depression with its jaws on the axils of the leaves and lays eggs in it. When the egg hatches, the young grub at once bores into the stem. It is a very small legless white insect with a slightly curved body (Fig. 10, Plate XXXIV) : it makes tunnels inside the stem, which extend about an inch up and down and about half way across the stem. When full-fed, it pupates inside the stem and comes out as an adult beetle in due course.

REMEDY.—The dried-up shoots, which have grubs in them, should be picked off and destroyed. This will prevent their increase and further loss would thus be stopped.

Reference.—I. I. P., p. 151.

IV.—FIBRES.

HOST: C. SANN HEMP.—*Crotolaria juncea*.

VERN. NAMES.—Beng.—*Shan*; Hindi—*San, Sanai*, Oriya—*Chhani*.

PEST—

(a) LEAF-EATING—

RED SPOTTED ERMINE MOTIL.—*Utthisa pulchella*, L.

NATURE OF DAMAGE.—The caterpillars of this moth feed on the leaves of Sann Hemp and eat the seeds by boring into the pods.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Hathwa. There are several broods in the year: the first generally appears in March or April and the big second one in June and July.

FOOD-PLANTS.—Sann Hemp. Leguminous weeds

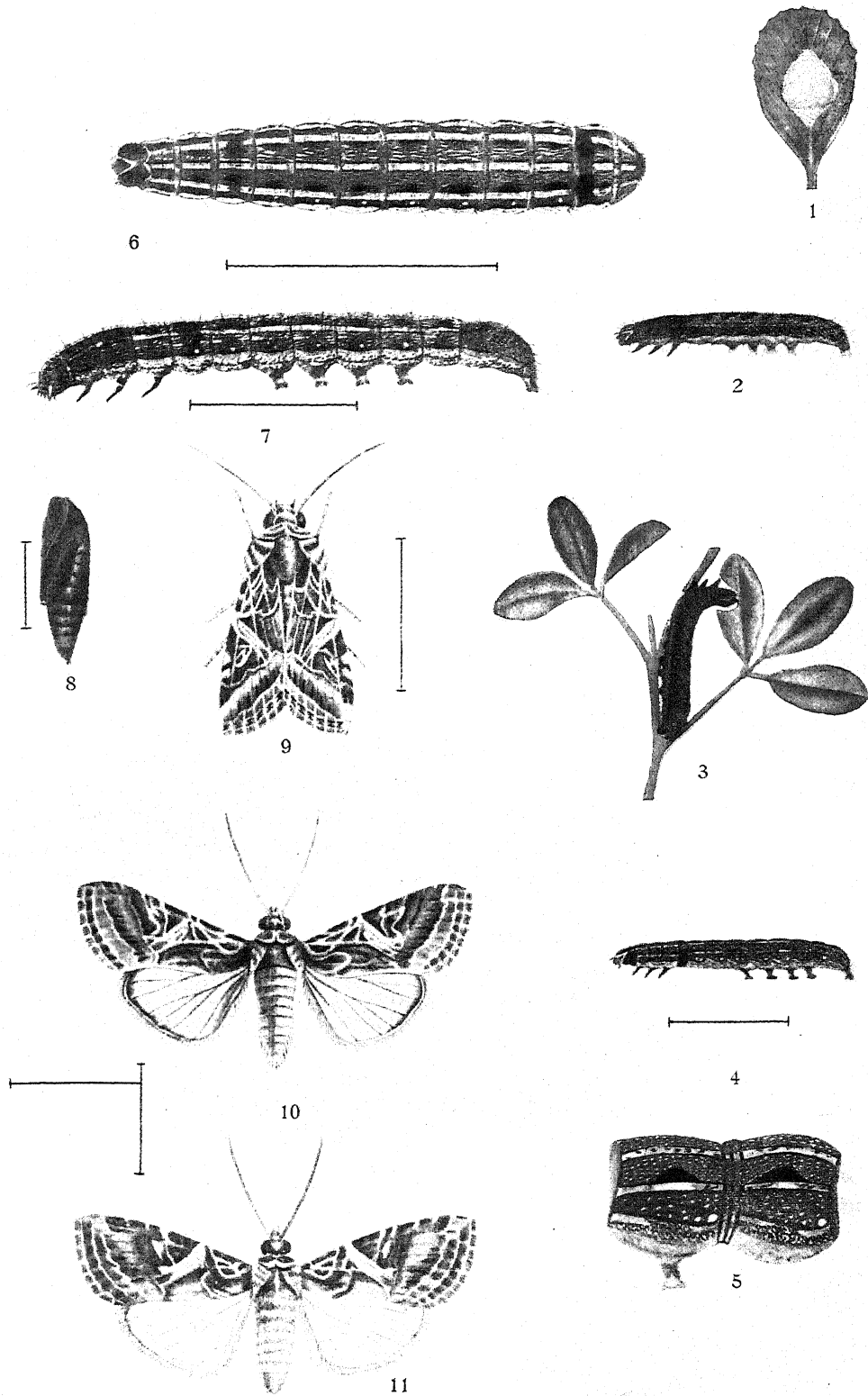
DESCRIPTION AND LIFE-HISTORY.—It is a medium-sized, handsome moth with red and black spots on the white forewings. The female moth lays a cluster of small white eggs on the lower surface of leaves. A caterpillar comes out in three or four days, feeds on the seeds inside the pods and on the leaves, and becomes full-grown in a fortnight when it measures about an inch. It is of a black velvety colour with yellow and red spots and a sprinkling of hair on the body. When full-fed, it comes down and pupates in the soil in a cocoon. The moths come out in a week.

REMEDY.—Clean cultivation is the best safeguard against this pest, as it deprives the caterpillars of their food-plants at a time when Sann Hemp is not available.

The caterpillars are prominent, and they should be picked off and destroyed.

Spraying with Lead Chromate or Arseniate checks them completely. (See Appendix No. III.)

Reference.—I. I. P., p. 148.



TOBACCO CATERPILLAR.

Fig. 1—Egg cluster on leaf. Figs. 2, 3, 4, 6, 7—Caterpillars in different stages of growth. Fig. 5—Two segments of caterpillar as seen from side. Fig. 8—Pupa. Fig. 9—Moth sitting. Figs. 10, 11—Moths as seen flying.
N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

V.—SPICES, DRUGS AND NARCOTICS.

HOST : A. TOBACCO—*Nicotiana tabacum*.VERN. NAMES.—Beng.—*Tāmāk* ; Hindi—*Tamākū* ; Oriya—*Jukta*, *Phūṇṇattā*.

PEST—

(b) LEAF-EATING—

TOBACCO CATERPILLAR—*Prodenia litura*, F.VERN. NAME.—*Ledā pokā*—Lower Bengal.

NATURE OF DAMAGE.—The caterpillar of this moth is a serious pest of tobacco and many other field crops. Like other leaf-eating caterpillars, it feeds on the leaves of the plants and causes serious loss to the grower.

LOCALITY AND TIME OF APPEARANCE.—As a pest of one or other of the crops mentioned in the list of food-plants given below, it occurs all over Bengal. On tobacco it generally appears in October and November, though its whole period of activity is from March to November.

FOOD-PLANTS.—Tobacco, Indigo, Lucerne, Castor, *Urid*, Cabbage, Cauliflower, Gram, Peas, *Musur*, *Khesari*, Sweetpotato, Potato, etc. In swarms it is fairly omnivorous.

DESCRIPTION AND LIFE-HISTORY.—It is a medium-sized dark brown moth, with irregular whitish lines on the forewings, the hind wings are white (Figs. 9—11, Plate XXXV). It is of nocturnal habits and remains concealed in sheltered positions during the day. Eggs are laid in clusters on the leaves of the food-plants and they are covered over with buff-coloured hairs (Fig. 1, Plate XXXV). Each cluster contains from 250—350 eggs. These eggs hatch in a week and the young caterpillars on emerging feed on the epidermis of the leaves. For the first few days they remain together in clusters and gradually separate and spread over the whole area. A full-grown caterpillar measures about an inch and a half, is of a velvety black or greenish black colour, with a dark swollen band across the body a little behind the head (Figs. 6, 7, Plate XXXV). When full-fed, it comes down off the plant and pupates in the soil without a cocoon (Fig. 8, Plate XXXV). The larval stage lasts about a month and a half in winter and about three weeks in summer. The pupal stage lasts about a month in winter and about a week in summer. The caterpillars are cannibalistic in habit and eat each other freely when food is not available.

REMEDY.—The buff-coloured prominent egg masses should be picked off and destroyed.

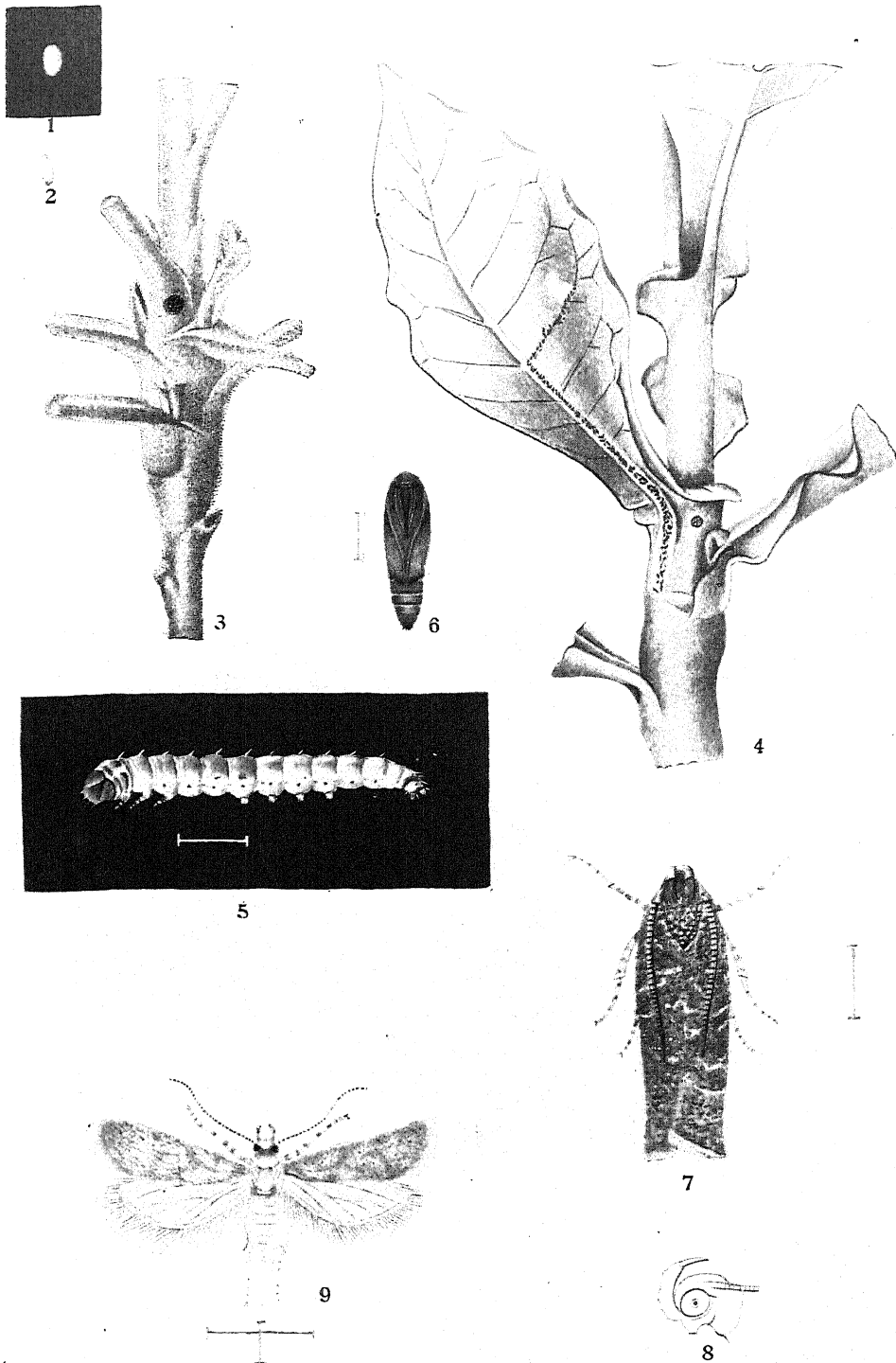
A radical cure is to be obtained by spraying with Lead Chromate or Arseniate (See Appendix No. III). In case of a big attack the area should first be trenched round and the trenches filled with water to stop it spreading. In tobacco cultivation, which is intensive, nothing but watchfulness and immediate destruction of the egg masses is of any avail.

The moths can be caught at night in a patent trap devised by Messrs. Andres Maire, Egypt, which trap is under experiment in India.

References.—I. I. P., pp. 156-157.

Mem. D. Ag. I., Vol. II, No. 5 (Ent. Series). The Tobacco Caterpillar, by H. M. Lefroy.

B. Q. J., Vol. IV, No. 4, Insect Pest of the Mokameh Tal, by E. J. Woodhouse and H. L. Dutt.



TOBACCO STEM BORER.

Fig. 1.—Egg when first laid magnified. Fig. 2.—Egg sometime after being laid magnified. Fig. 3.—Affected plant with bulbous swelling with hole of exit of the moth. Fig. 4.—Affected plant showing entry of the borer from leaf into the stem with hole of exit of the moth. Fig. 5.—Fullgrown caterpillar. Fig. 6.—Pupa from below. Fig. 7.—Moth as seen on plant. Fig. 8.—Sickle-shaped palpi of the moth. Fig. 9.—Moth as seen flying.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

V.—SPICES, DRUGS & NARCOTICS.

HOST : A. TOBACCO.—*Nicotiana tabacum*.VERN. NAMES.—Beng.—*Tāmāk* ; Hindi—*Tamākū* ; Oriya—*Dukta. Dhūānpatra*.

PEST—

(c) STEM-BORING—

TOBACCO STEM-BORER.—*Gnorimoschema heliope*, Low.

NATURE OF DAMAGE.—The caterpillars of this moth live inside the stems of tobacco plants and cause gall-like swellings. An attacked plant does not die but becomes weak and yields little.

LOCALITY AND TIME OF APPEARANCE.—It is fairly common in the tobacco-growing areas in Behar. It generally attacks the plant after transplantation.

FOOD-PLANT.—Tobacco.

DESCRIPTION AND LIFE-HISTORY.—It is a small brown moth with narrow fringed wings (Figs. 7—9, Plate XXXVI). Eggs are laid by the female singly on the leaves, each moth laying from 60—70 (Figs. 1-2, Plate XXXVI). In winter, these eggs hatch in a month and a young caterpillar eats into the leaf or stem. When inside a leaf the caterpillar makes its way into the midrib through a vein and along the midrib towards the stem, until it reaches the main stem of the shoot (Fig. 4, Plate XXXVI). It lives inside and feeds on the tissue giving rise to a swelling at that point (Fig. 3, Plate XXXVI). If a swelling be opened up, the caterpillar itself will be found inside or signs of its presence will be noticed there. It becomes full-grown in six to ten weeks when it measures about half of an inch, is of a white colour with a dark head (Fig. 5, Plate XXXVI). When full-fed, it first makes an opening at one side of the stem and then pupates inside. In cold weather the moth emerges from the pupa in about a month and comes out through the opening to lay its eggs.

REMEDY.—Watch the crop from the beginning and pull out and burn the plants with the swellings described above.

Destroy the stumps of plants after the crop is cut, so that the insects may not go on breeding in the fresh shoots coming out of them.

Stray and wild tobacco plants should be destroyed.

References.—I. I. P., p. 156.

A. J. I., Vol. III, The Tobacco Stem-borer, by H. M. Lefroy,
pp. 65—68.

V.—SPICES, DRUGS AND NARCOTICS.

HOST : A. TOBACCO—*Nicotiana tabacum*.VERN. NAMES.—Beng.—*Tāmāk* ; Hindi—*Tamākū* ; Oriya—*Dukta*, *Dhūānpatra*.

PEST—

(e) LEAF-EATING—

LARGE BROWN CRICKET.—*Brachytrypes arhatinus*, St.VERN. NAMES.—*Jhīlī*, *Uchāngra*—L. Bengal ; *Jhāngra*—Behar.

NATURE OF DAMAGE.—This cricket lives in holes in fields and comes out only at night to cut off the shoots of young plants and eat the leaves. It is indirectly injurious to plants as it cuts through the roots when making its burrows.

LOCALITY AND TIME OF APPEARANCE.—It is to be found all over Bengal. During the hot weather it remains inside its subterranean burrows and comes up in the rains. In tobacco fields it appears when the plants are young.

FOOD-PLANTS.—Tobacco, Indigo, Lucerne, Weeds.

DESCRIPTION AND LIFE-HISTORY.—This cricket is of a fairly large size and of a deep brown colour. It lives in subterranean burrows and never comes out during the day. Towards the end of the rainy season a female cricket lays about 40—50 eggs in a mass at the farthest end of its burrow ; these eggs generally hatch in September. The young crickets come out of the old burrow and make holes of their own. Their nests in the field can be located by the loosened and slightly raised earth near the opening. The young ones look like the adults except that they are smaller in size and not provided with wings which gradually develop with the growth of the insects. The adult crickets rarely fly, though they are provided with two pairs of perfect wings, their chief method of locomotion being jumping. At night their shrill music can be heard from a long distance. The damage to the plants is done only at night.

ENEMIES.—This cricket has a great enemy in a metallic-green Digger-wasp (Vern. *Kanch poka*), which lays eggs on its body and buries it in its own burrow.

REMEDY.—Flooding brings them up to the surface when they are eaten by birds. Green vegetation should be sprayed with Lead Chromate and placed in different parts of the fields. The crickets will come out at night and feed on these. A large number of them can thus be killed.

References.—I. I. P., p 225.

Mem. D. Ag. I., Vol. IV, No. 3 (Ent. Series), The Big Brown Cricket, by C. C. Ghosh.

V.—SPICES, DRUGS AND NARCOTICS.

HOST : D. GINGER—*Zingiber officinale*.VERN. NAMES.—Beng.—*Ada* ; Behari—*Adrak* ; Oriya—*Ada*.

PEST—

FUNGUS, SOFT ROT.—*Pythium gracile*, Schenk.

DESCRIPTION.—This disease, though not very common, has been reported from several places causing considerable damage to the ginger crop. It is marked by the withering of the leaves (Plate XXXVII) of the affected plants which on examination show a certain softening at the collar due to a rot set up by the fungus, in consequence of which the plants break down. In severe cases the rhizomes and roots are also found to be rotten and disorganized into pulpy masses : they do not produce new rhizomes and the crop fails. The disease is favoured by excessive moisture.

REMEDY.—Water-logging, lowlying situations and over-irrigation should be avoided and the affected areas should be exposed to the sun and air by occasionally turning over the earth. Diseased roots and rhizomes should be removed and burnt and rhizomes from diseased areas should not be used for seed purpose.

Reference.—A. J. I., Vol. VI, Part II, Soft Rot of Ginger, etc., by W. McRae.



BORERS OF SUGARCANE.

Fig. 1.—Egg cluster of White Borer. Fig. 2.—Moth of the same. Fig. 3.—Chrysalis of same in the cane. Fig. 4.—Egg cluster of Moth Borer. Fig. 5.—Caterpillar of the same. Fig. 6.—Moth of the same. Fig. 7.—Caterpillar of Root Borer in young cane. Fig. 8.—Moth of the same.

VI.—SUGAR.

HOST : A. SUGARCANE—*Saccharum officinarum*.

VERN. NAMES.—Beng.—*Ak, Ikshu* ; Hindi—*Ukh, ketārā* ; Oriya—*Akhā*.

PEST—

(c) BORING—

MOTH-BORER.—*Chilo simplex*, Butl.

VERN. NAMES.—*Gondālā, Goricālā, Gorindā, Bokpokā*—Cuttack ; *Majrā*—L. Bengal ; *Dhasā*—Bengal ; *Garhsukhu*—Gaya ; *Mooriā*—Bhagalpur ; *Pihikā*—Shahabad.

NATURE OF DAMAGE.—The caterpillars of this moth are chiefly injurious to young canes during the first three months of their growth. They bore into the young shoots and feed inside. Every bored young shoot dies. New shoots are formed from the sides which grow up into canes if they escape attack. When the cane crop becomes old, *i.e.*, when the joints have formed, the caterpillar lives in the joints and does not cause the death of the cane shoots. The damage done in old canes is due to the reduction in the yield of sugar.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Cuttack and Sabour. It occurs practically all over Bengal. Moth-borers attack young canes up to five months from the date of planting and would not remain in the cane after that if sorghum or maize be available.

FOOD-PLANTS.—Sugarcane (shoots and canes), Maize (stem, cobs and tassels), Juar (stem and shoots), *Bajra* (stem), Paddy (stem).

DESCRIPTION AND LIFE-HISTORY.—The moth is small and of a yellowish grey colour (Fig. 6, Plate XXXVIII). The male is smaller and darker than the female. They hide themselves under leaves or ground during the day and come out and fly about in the dusk and at night. Eggs are laid by the female moths in clusters on the leaves (Fig. 4, Plate XXXVIII). They are arranged in rows side by side and fastened to the leaf. The eggs hatch in a week and the caterpillars on emerging feed on the epidermis for some time and then enter the shoot or stem. When the caterpillar becomes larger it tunnels into the heart of the cane and feeds on the rolled-up centre leaves or the growing point of the same. The centre leaves are cut through and the centre shoots consequently wither. The dead shoots are known as “dead hearts.” The caterpillar lives for about four weeks inside the stem. A full-grown caterpillar measures about an inch with a dirty white body and a black head (Fig. 5, Plate XXXVIII). There is

a dark patch behind the head and two dark lines running from the head to the hind end of the body. All over the body there are small hairs set on black dots. When full fed, the caterpillar pupates inside the tunnel and comes out as moth after five or six days. The life-history is usually completed in some six weeks.

REMEDY.—Cut off and destroy all the withering shoots as soon as they are first seen. They must be either buried deep in the soil or burnt. These should be cut low down just below the soil, so that the caterpillars, etc., are taken away with them.

Sow Maize or Sorghum as trap crop among canes when the cane is planted. This will come up more quickly and the moth-borer will lay eggs on these. These plants, with the caterpillars inside, should be removed and destroyed about two months after sowing.

When Maize or Sorghum is harvested, destroy the stubble left on the field as the caterpillar lives through in it till paddy is available. A great number of the caterpillars can be destroyed in this way.

ENEMY.—The caterpillars have some parasites which live inside their bodies and kill them. (See Appendix No. VII.)

References.—I. I. P., p. 125.

A. J. I., Vol. I, Moth-borer in Sugarcane etc., by H. M. Lefroy, pp. 97-115.

A. J. I., Vol. III, The Sugarcane Borers of Behar, by M. Mackenzie and H. M. Lefroy, pp. 104-124.

VI.—SUGAR.

HOST : A. SUGARCANE—*Saccharum officinarum*.

VERN. NAMES.—Beng.—*Ak, Ikshu* ; Hindi—*Ukh, Ketūrī* ; Oriya—*Ālhā*.

PEST—

(c) BORING—

WHITE BORER—*Scirpophaga auriflua*, Zell.

VERN. NAMES.—*Garhsukhu*—Gaya ; *Majrā*—L. Bengal ; *Mooriā*—Bhagalpur ; *Pihikā*—Shahabad.

NATURE OF DAMAGE.—The caterpillars of this moth are found principally at the apex of the cane boring through the growing joint and down the upper joints and so causing the top shoots to wither. Such a dead top-shoot, known as “dead heart,” comes off easily if pulled. The death of the growing point stimulates the growth of the buds below it, and the result is that fresh green shoots come out. In old canes owing to the growth of these side shoots the cane forms a bunchy top, which is typical of a cane bored by the white borer.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Dumraon, Chapra, Sabour and Cuttack. It is a serious pest of cane in Behar. Where canes are planted in January or February, the attack does not generally begin till the end of March. The pest is not active in the cold weather.

FOOD-PLANTS.—Sugarcane and *Munj* grass.

DESCRIPTION AND LIFE-HISTORY.—It is a medium-sized moth of a white colour, with a dense tuft of buff hairs at the hind end of the body (Fig. 2, Plate XXXVIII). During the day they can be found in the fields sitting on the leaves, but their activity begins after dusk. The eggs are laid in clusters on the underside of the top leaves (Fig. 1, Plate XXXVIII). Each cluster is covered over with buff-coloured hairs and contain generally from 60 to 80 eggs. They hatch in 10—12 days. A young caterpillar bores into the unfurled leaves on the terminal shoots of the cane stem. It gradually travels downwards till it reaches the sappy portion of the stem, where it feeds on the tissues and thus destroys the cane. In about 22 days a caterpillar becomes full-grown, when it measures about three-quarters of an inch and is of a creamy white colour with a yellow head. When full-fed, it alters its direction and tunnels towards the bark of the cane through which it cuts a small circular hole. Then the caterpillar webs up several silken partitions across the opening and pupates behind them (Fig. 3, Plate XXXVIII). The moth comes out in 10—12 days and starts laying eggs again.

ENEMY.—There are a few small parasites whose young ones feed on the eggs or the bodies of these caterpillars, which consequently die.

REMEDY.—The withering young shoots should be cut off and destroyed with the insects in them. The bunchy tops harbour the caterpillar during the winter. Such tops should be destroyed or fed to cattle or put in a compost pit. They should never be left in the field or stacked, since in time the moths would come out of them if they are not destroyed.

The moths are attracted to light, so many of them can be easily killed before egg-laying by lighting bonfires in the cane fields for some consecutive days.

The egg masses are characteristic and should be collected. Instead of destroying them, they should be placed on a dish standing in a large dish of water. If this is done, any parasites in the eggs will hatch out and fly away and destroy other eggs, while the healthy caterpillars cannot escape.

References.—I. I. P., p. 130.

A. J. I., Vol. III, The Sugarcane Borers of Behar, by M. Mackenzie and H. M. Lefroy, pp. 104-124.

VI.—SUGAR.

HOST : A. SUGARCANE—*Saccharum officinarum*.

VERN. NAMES.—Beng.—*Ak, Ikshu* ; Hindi—*Ukh, ketūrī* ; Oriya—*Akhū*.

PEST—

(d) ROOTS—

CANE ROOT BORER.—*Poliocha sacchitrella*, Ddgn.

NATURE OF DAMAGE.—The caterpillars of this moth live and feed inside the roots of sugarcane. The result is that the plant becomes stunted and assumes a shrivelled-up appearance, and in many cases the whole stool dries up.

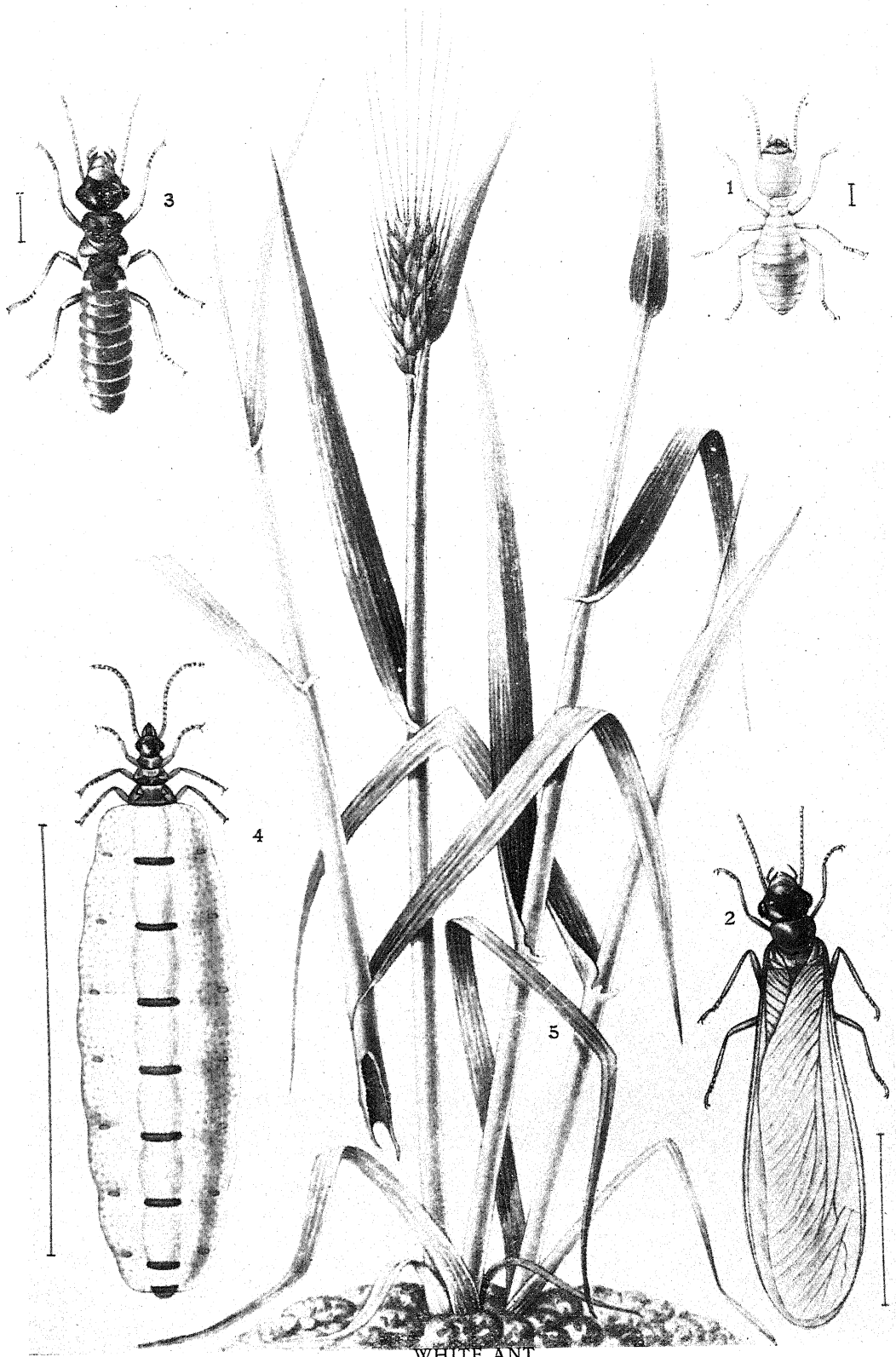
LOCALITY AND TIME OF APPEARANCE.—It is a definite pest of cane in Behar. The attack begins when the crop is a month old, *i.e.*, about the end of March or beginning of April.

FOOD-PLANT.—Sugarcane.

DESCRIPTION AND LIFE-HISTORY.—It is a small brown moth with hind wings white (Fig. 8, Plate XXXVIII). The caterpillars commence life by boring into the stem low down and then tunnelling down into the roots. A full-grown caterpillar is about three-quarters of an inch in length and is of a white colour (Fig. 7, Plate XXXVIII). Before it pupates it comes up to the soil level, makes an opening in the stem and covers it up with silk. Then it goes down into the root again to pupate, and in due course, the moth emerges. Since it goes from root to root, ratooning is impossible where it is present. It passes the winter (November-April) as a larva in the roots without eating anything.

REMEDY.—As soon as the crop is harvested, take off the stools of the plants and destroy them either by putting them in a compost pit or by burning.

Reference.—A. J. I., Vol. III, The Sugarcane Borers of Behar, by M. Mackenzie and H. M. Lefroy, pp. 104-124.



WHITE ANT.

Fig. 1.—Worker. Fig. 2.—Winged form may be male or female. Fig. 3.—A female after shedding her wings. Fig. 4.—A Queen. Fig. 5.—An affected wheat plant; on the right hand side is shown a plant dying on account of attack by white ants; on the left hand side an affected plant has been pulled up to show how it has been eaten under soil.

V.B.—In cases where the insects have been drawn larger than life-size, the hair lines beside them indicate their natural size.

VI.—SUGAR.

HOST : A. SUGARCANE.—*Saccharum officinarum*.VERN. NAMES.—Beng.—*Ak, Ikshu* : Hindi—*Ukh, ketārī* : Oriya—*Akhū*.

PEST—

(d) ROOTS—

WHITE ANT.—*Termes* sp.VERN. NAMES.—*Wē*—L. Bengal: *Bādlā pokā*—L. Bengal: *Dīgār*—Behar: *Dimak*—Behar: *Jharī*—Orissa: *Bhuslā*—Ranchi: *Dewānt*—Hazari-bagh.

NATURE OF DAMAGE.—Termites or white ants are serious enemies to young canes. They attack the setts when these are planted. They also cut the stems of the young cane plants just under the surface of the soil. A plant attacked by white ants can at once be distinguished from one attacked by borers by the fact that in the first case the whole plant dies, whereas in the second only the centre shoot.

LOCALITY AND TIME OF APPEARANCE.—It attacks sugarcane wherever it is grown in Bengal. As has been said above, it is to be found chiefly in the young stages of the plant.

FOOD-PLANTS.—Timber trees, Sugarcane, Wheat, Groundnut, Sunflower, Safflower, Juar, Mango, and most field crops and garden plants.

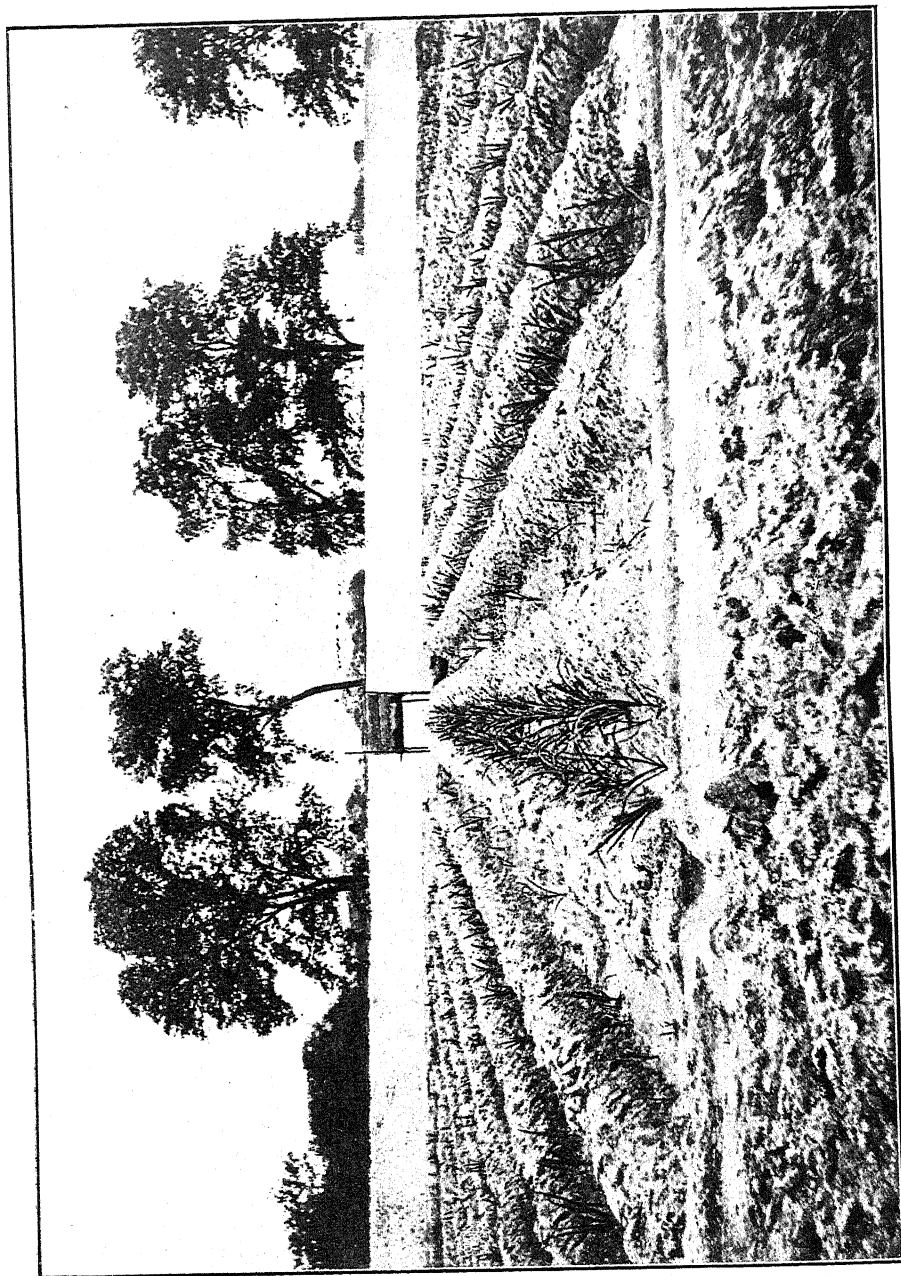
DESCRIPTION AND LIFE-HISTORY.—The white ant is too common an insect to need any description. What we generally see in buildings, trees, cotton stumps, etc., are the sexually immature workers (Fig. 1, Plate XXXIX). They shun light and would never willingly expose themselves to it. Their main nest is generally underground, sometimes it projects above the ground. Tunnels of enormous length run over or underground in every direction from the main nest. The workers collect food for the whole colony. Besides the workers there are in a nest a fully-developed queen (Fig. 4, Plate XXXIX), a few imperfectly-developed queens and a male. These are the true sexed forms. At certain times during the rainy season, winged male and female white ants (Vern. *Baulla poku*) swarm out and take flight (Fig. 2, Plate XXXIX). They have many enemies and they are soon killed. A few females come down, divest themselves of their wings and start fresh colonies (Fig. 3, Plate XXXIX). Many new colonies are thus started but the chances of a successful colony are very small.

REMEDY.—The best remedy for white ant is to find out the nest, dig it up and burn it or to pour low grade kerosine oil or carbon bisulphide into the nest. But this is not easy and the nests in many cases are not easy to find. In case of sugarcane

the setts should be dipped in cold saturated copper sulphate solution or in sanitary fluid (1 in 4) or in Crude Oil Emulsion (1 in 4) before planting. A small quantity of Crude Oil Emulsion in the irrigation water is also very effective; a bag containing this emulsion should be so placed in the main irrigation channel that only a small quantity of it is carried along with the water.

As white ants are attracted by farm-yard manure or stable manure, care should be taken to apply only well rotted manure.

Reference.—I. I. P., pp. 228-231.



RED ROT OF SUGARCANE (*Colletotrichum Falcatum*.)

Healthy and diseased sets have been planted in alternate lines.

VI.—SUGAR.

HOST : SUGARCANE.—*Saccharum officinarum*.VERN. NAMES.—Beng.—*Ak* ; Behari—*Ukh* ; Oriya—*Alkhū*.

PEST—

FUNGUS—

RED-ROT.—*Colletotrichum falcatum*, Went.

DESCRIPTION.—The most formidable disease of the sugarcane is the “red-rot” which causes considerable damage and sometimes even the total failure of the crop. It is present more or less everywhere. The first symptom of the disease is the withering of some of the young leaves of the crown. This withering continues until the whole crown is affected ; then the cane begins to dry up and shrink and finally assumes a dead and shrivelled appearance. The attack usually begins from the base—mostly from the seed cane, that is, the cutting which had been used for planting, and when one cane is found diseased, frequently the whole stool is found more or less affected, as may be seen by cutting up the canes lengthwise when reddening of the inside of the canes may be noticed : hence the name “red-rot.”

REMEDY.—Careful selection of setts (Plate XL), which should be perfectly free from the slightest trace of reddening, and the burning of all diseased and dead portions of the cane may considerably check the spread of the disease. It may also be found profitable to plant only certain varieties of canes which are less liable to the above disease.

Reference.—Mem. D. Ag. I. (Bot. Series), Vol. I, No. 3, Fungus Diseases of Sugarcane in Bengal, by Dr. E. J. Butler.

VI.—SUGAR.

HOST : SUGARCANE.—*Saccharum officinarum*.

VERN. NAMES.—Bengali—*Ak* ; Behari—*Ukh* ; Oriya—*Akhu*.

PEST—

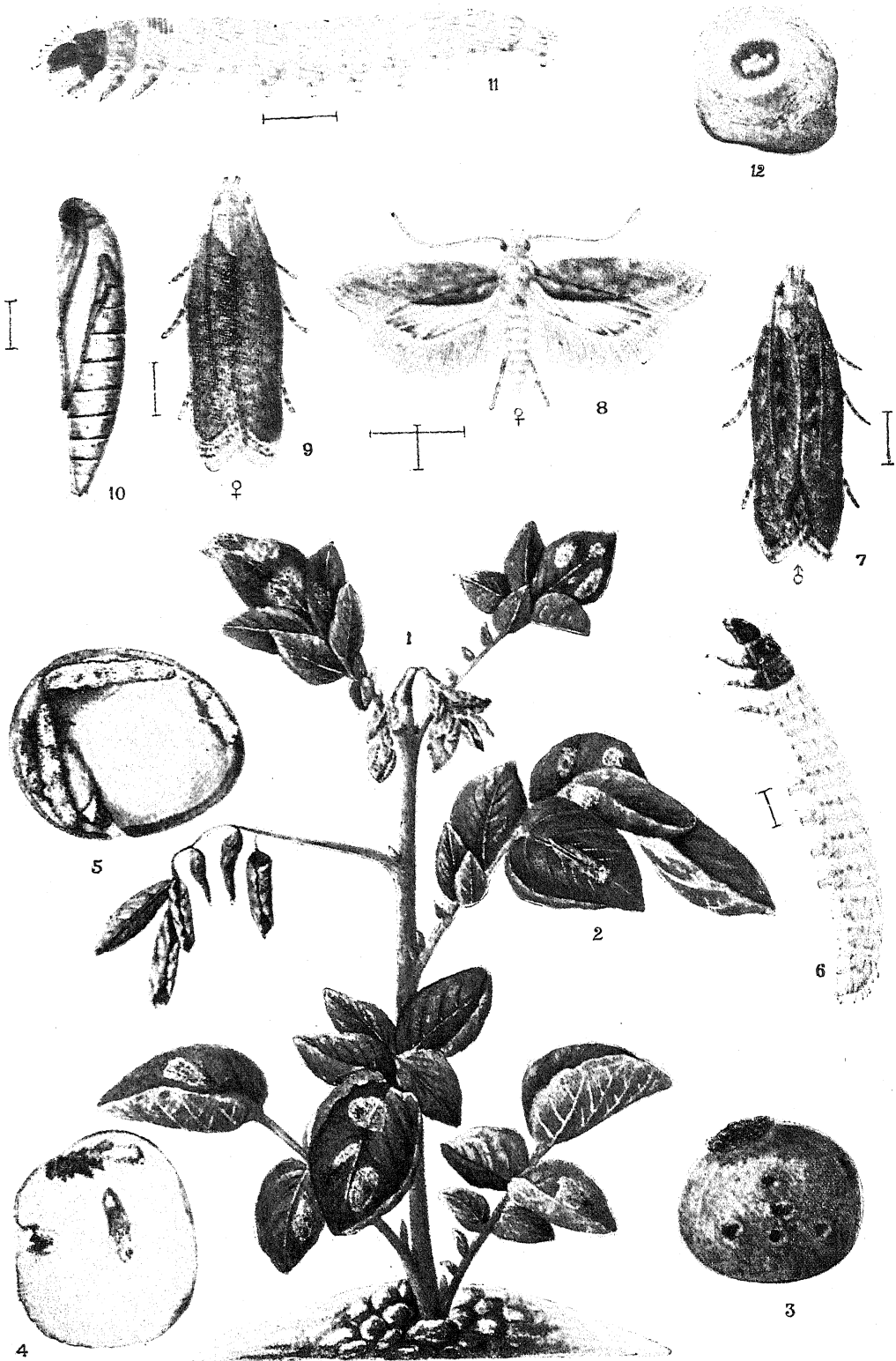
FUNGUS-SMUT.—*Ustilago sacchari*, Rab.

DESCRIPTION.—This is a disease of one or two of the most common varieties of cane, such as the “Khari” in which it is almost invariably present and may cause serious damage. Like the “red rot” it may also have its origin in the setts used as cuttings, though infection by spores may also take place. The disease appears at all times of the season when the crop is standing and all the canes from the youngest shoots to the most mature ones have been found to develop the disease. The black smutted canes are peculiar in appearance, the stem being prolonged into a whip-like structure, often much twisted and curved on itself (Plate XLI). It contains innumerable spores of the fungus which fall off as a black sooty powder.

REMEDY.—The disease can be kept in check by burning all affected clumps and by selecting setts from healthy plants.

References.—Mem. D. Ag. I. (Bot. Series), Vol. I, No. 3, Fungus Diseases of Sugarcane in Bengal, by Dr. E. J. Butler.

B. Q. J., Vol. V, No. 2, Observations on the Smut Disease of Sugarcane, etc., by S. K. Basu.



POTATO MOTH.

Fig. 1.—A potato plant damaged by caterpillars. Fig. 2.—Moth resting on plant. Fig. 3.—A damaged tuber with excrements at the eyes. Figs. 4, 5.—Damaged potato tubers. Fig. 6.—Young caterpillar. Fig. 7.—Male moth while sitting. Fig. 8.—Female moth with wings set. Fig. 9.—Female moth. Fig. 10.—Pupa. Fig. 11.—Fullgrown caterpillar. Fig. 12.—Eggs on a tuber.
N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

VIII.—VEGETABLES.

HOST : A. POTATO—*Solanum tuberosum*.

VERN. NAMES.—Bengali—*Gol Alu* ; Hindi—*Alu* ; Oriya—*Vilayati Alū*.

PEST—

AFFECTING STORED POTATOES—

POTATO MOTH.—*Phthorimera operculella*, Zell.

VERN. NAME.—*Alūr poka*—L. Bengal.

NATURE OF DAMAGE.—The caterpillars of this moth attack both the crop in the field and the stored tubers in godowns : in the field they mine the leaves and bore the stems of the plants and sometimes into the exposed tubers. In godowns they bore into the tubers and feed on their substance, causing them to rot during the rains. The attacked tubers in a godown can be distinguished by the presence of their black excreta near the eye-buds (Fig. 3, Plate XLII).

LOCALITY AND TIME OF APPEARANCE.—It first appeared at Patna and its neighbourhood in 1907 and has since then spread nearly all over the Province. It is first found in January or February attacking tubers, in the field and in godowns it remains active generally from March to October. It is a very serious pest of stored potatoes.

FOOD-PLANT.—Potato (in India).

DESCRIPTION AND LIFE-HISTORY.—It is a very small moth of a dark brown colour, having a fringe of hair on the posterior margin of the hind wing (Fig. 8, Plate XLII). A female moth lays eggs on the eyes of the tubers stored in a godown (Fig. 12, Plate XLII), and in the field on those that are not well covered with earth. The eggs hatch in a few days and a young caterpillar bores into the tuber at once and feed on its substance, by tunnelling in all directions (Fig. 5, Plate XLII). In 10–15 days a caterpillar becomes full-fed when it generally comes out of the tuber and turns into a red-brown chrysalis (Fig. 10, Plate XLII) in a silken cocoon. A full-grown caterpillar is about $\frac{1}{2}$ " long and is of a dirty white colour with a black head (Fig. 11, Plate XLII). The moths come out of the pupæ in a short time and lay eggs on fresh tubers which are ordinarily left exposed in cultivators' godowns and in a short time may infect all the tubers stored. At the beginning of the rainy season the affected tubers begin to rot and the sound tubers soon begin to do the same. In bad cases the loss in a godown may be as much as one hundred per cent.

REMEDY.—Egg-laying on the exposed tubers in the field may be checked by judiciously widening the ridges in the potato plots and covering up the exposed tubers after each irrigation.

When the crop is harvested and brought into the godown, the affected tubers with black spots on the eyes should be picked off and rejected, and the healthy tubers should then be spread on a layer of dry sand on the floor or on machans, the height of a heap not exceeding 18 inches, and covered up with dry river sand completely, so that no tubers may be seen through the sand. The sand should be thoroughly dried and cooled before use. The heaps should be picked over after 15 days, the affected tubers rejected and the healthy tubers covered up again with sand as before. Picking should be done once a month in dry weather and once every 15 days in the rainy season. In wet weather the sand may be taken off the tubers if the potato moth has disappeared, but they must be covered up again directly traces of renewed damage become evident.

The object of covering the potatoes with sand is to hinder the moths reaching the tubers and so to prevent them from laying their eggs. It is only necessary to cover up the tubers in sand so long as the potato moth is about.

In selecting a godown the following points should be observed :—

(1) The floor should be raised above the ground level outside ; the roofs and walls must be water-tight. In moist climates the tubers must be stored on machans rather than on the floor. *The godown must be as dry as possible.* (2) *The room should have good ventilation arrangements, i.e.,* there should be spaces between the roof and tops of the side wall, there should be windows or holes just above the machans ; there should also be ample space between the topmost machan and the roof to prevent the heat becoming excessive on the topmost machan.

In case it is desired to store in baskets, these should first be plastered over with mud and dried thoroughly. The potatoes may then be put in the baskets and covered up completely with a layer of sand on the top. Picking should be done at the usual intervals.

References.—A. J. I., Vol. V, No. 1, pp. 19-28, Experiments in the Storage of Seed Potatoes, by H. M. Lefroy and G. Evans.

A. J. I., Vol. II, p. 294, The Potato Moth, by H. M. Lefroy.

B. Q. J., Vol. IV, No. 4, Potato Moth at Patna, by E. J. Woodhouse and A. P. Choudhury.

B. Q. J., Vol. V, No. 3, Potato Moth at Patna, by E. J. Woodhouse.

A. J. I., Vol. VII, No. 3, Potato Moth in Bengal, by E. J. Woodhouse.

VIII.—VEGETABLES.

HOST : A. POTATO—*Solanum tuberosum*.VERN. NAMES.—Bengali—*Alu* ; Behari—*Alu* ; Oriya—*Alu*

PEST—

FUNGUS.—EARLY BLIGHT.—*Macrosporium solani*. E. & M.

DESCRIPTION.—The early blight of potato is a serious and widespread disease, often causing considerable damage to the crop. As its name implies, the disease appears early, causing early death of the leaves and consequently withering of the vines. In severe cases very few tubers are developed which are also very much reduced in size, and the loss in some places has been estimated to exceed 50% of the crop. The disease appears on the leaves first as small circular or elliptical brown patches which are often distinctly marked with concentric rings ; these expand and sometimes cover a large part of the leaves. The fungus spores are found in these patches. Although the fungus is said to be truly parasitic, yet the weakened condition of the plants encourages a rapid spread of the disease ; it spreads particularly fast in dry weather and in dry situations, when the plants become weakened by excessive heat and dryness.

REMEDY.—The disease is amenable to treatment. Application of Bordeaux mixture (*vide* Appendix No. IX) has been found to be very beneficial in such attacks.

VIII.—VEGETABLES.

HOST : A. POTATO—*Solanum tuberosum*.VERN. NAMES.—Bengali—*Alu* : Behari—*Alu* : Oriya—*Alu*.

PEST—

FUNGUS.—*Rhizoctonia solani*, Kuhn.

DESCRIPTION.—This disease has been reported from several potato-growing areas, chiefly about Bankipore. As a result of the attack the plants wither and finally die. Its effect is not unlike that of the *wilt* disease of Arhar. The root and the tuber are the parts which are chiefly attacked and the fungus is found both within them and also covering them with light violet or brown-coloured web-like mycelial threads. These threads sometimes unite to form root-like strands. Small dark-coloured specks about the size of a small pigeon pea are also noticed among these threads ; these are not spores of the fungus, but are merely knots formed by the compact aggregation of these threads which are capable of growing vegetatively. The fungus spreads outwards under the ground from a centre and may cover large areas. It is said to remain alive in the soil for many years. Affected tubers rot in the godowns.

A similar fungus, namely, *Rhizoctonia violacea*, Tul, attacks several other crops such as jute, agave, cotton, etc., causing considerable damage.

REMEDY.—The best remedy in the case of potato lies in the careful selection of clean seed and its treatment with Formalin before planting (*vide* Appendix No. XI). Trenching may be tried to check the progress of the disease. The diseased plants should be carefully removed and burnt, and if possible the areas should be cropped with Cereals which are not liable to be affected by this parasite.

VIII.—VEGETABLES.

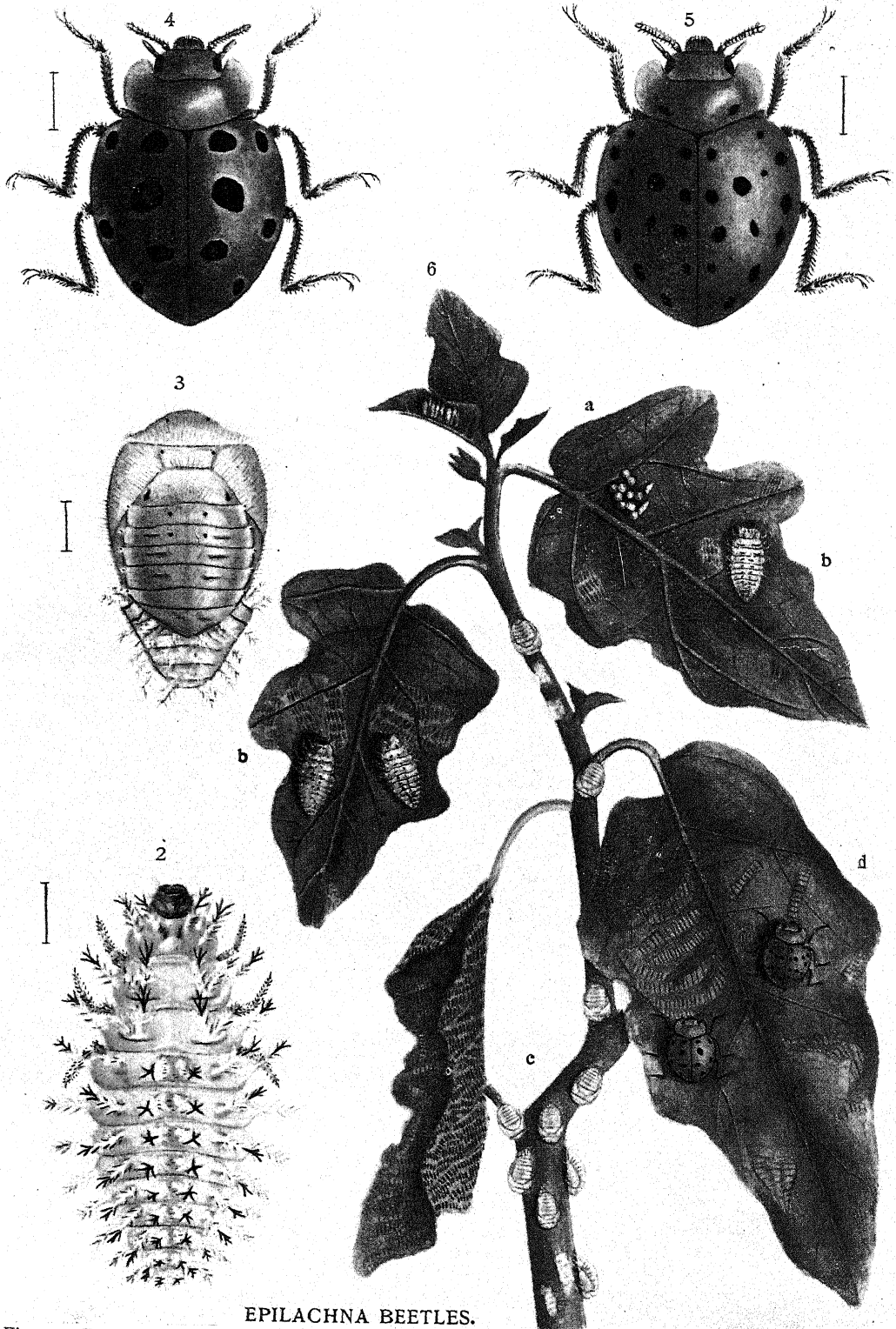
HOST : A. POTATO—*Solanum tuberosum*.VERN. NAMES.—Beng.—*Alu* ; Behari—*Alu* ; Oriya—*Alu*.

PEST—

A BACTERIAL DISEASE—

DESCRIPTION.—This disease of potato is also known to occur on several other Solanaceous crops such as tobacco, tomato, brinjal and chillies. On potato and tobacco, however, it has caused serious damage. The disease is marked by the wilting of the foliage when first observed in the field ; then the smaller branches become blackened or otherwise discoloured ; these ultimately die as also some of the older branches. On cutting sections of the diseased stem the wood vessels show a brownish discolouration due to their being filled up by innumerable minute bacteria. In the case of potato tubers the disease becomes manifest by the presence of a brown ring a little distance away from the surface as can be seen by cutting a tuber into halves. This ring gradually enlarges and becomes darker, ultimately filling up the whole tuber with a rotten pulpy mass until nothing but the skin remains.

REMEDY.—The disease is said to be spread through the agency of insects and it is recommended to treat the plants with an insecticide. In the case of potato, diseased tubers are also capable of producing the disease if used for seed purpose. They should therefore be carefully eliminated from the healthy seeds and burnt. Where the disease shows any tendency to spread, the crop should be lifted early, dried in the sun and used for the table at once.



EPILOCHNA BEETLES.

Fig. 1.—Egg. Fig. 2.—Grub. Fig. 3.—Pupa. Fig. 4.—12-spotted Epilachna. Fig. 5.—28-spotted Epilachna. Fig. 6.—Brinjal plant with (a) egg-cluster on leaves; (b) grubs feeding on leaves; (c) pupæ on stem; and (d) beetles feeding on leaves.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

VIII.—VEGETABLES.

HOST : B. PUMPKINS.

PEST—

(a) LEAF-EATING—

28-SPOTTED EPILACHNA.—*Epilachna 28-punctata*, F.12-SPOTTED EPILACHNA.—*Epilachna dodecastigma*, Muls.VERN. NAMES.—*Kankar poka*—Orissa ; *Baga poka*, *Kantale poka*—L. Bengal.

NATURE OF DAMAGE.—These Ladybird beetles feed on the leaves of cucurbits, brinjal, potato, etc., both in their young and adult stages. They take a series of bites off the epidermis of the leaves and produce a characteristic stippled appearance on them. When abundant, the epidermal layer of all the leaves may be eaten off, in consequence of which the plant withers.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Cuttack. They are more or less common in vegetable gardens all over Bengal. They are most abundant from July to November, passing the winter as adult beetles.

FOOD-PLANTS.—Cucurbitaceous plants, brinjal, potato.

DESCRIPTION AND LIFE-HISTORY.—It is a small round, dull-red beetle, shaped more or less like a split pea, with black dots on its wings (Figs. 4, 5, Plate XLIV). One species has got 12 and another 28 such dots. Eggs are laid by the female beetle in clusters on the leaf (Fig. 6a, Plate XLIV). They hatch in about five days, and the young grubs, on emerging, at once start feeding on the epidermis of the leaves (Fig. 6b, Plate XLIV). A young grub changes its skin several times during its larval period—three to four weeks—after which it pupates openly on the leaf suspended by its tail (Fig. 6c, 3, Plate XLIV). A full-grown grub is yellow, about one quarter of an inch long, flattened and oval, and covered with short spines (Fig. 2, Plate XLIV). It clings tightly to the leaves and moves very slowly. The adult beetles come out of the pupæ in 4 to 6 days and lay eggs again.

REMEDY.—The simplest method is hand-picking.

Dusting the plant with a mixture of wood-ash and kerosine is very effective ; it makes the leaves distasteful and drives the insects away.

Spraying with Lead Chromate or Arseniate is a radical cure. (See Appendix No. III).

Reference.—I. I. P., pp. 204-205.

VIII.—VEGETABLES.

HOST : B. PUMPKINS.

PEST—

(a) LEAF-EATING—

RED PUMPKIN BEETLE.—*Aulacophora joveicollis*, Kust.VERN. NAME.—*Khapra*, Behar.

NATURE OF DAMAGE.—This beetle eats holes in the leaves of young cucurbitaceous plants. In some cases they eat up the leaves of young seedlings completely, and thus kill them. In old plants they cannot do much damage.

LOCALITY AND TIME OF APPEARANCE.—It is probably present all over Bengal and can be found all the year round except during winter : it becomes most abundant in spring when it does much damage to cucurbitaceous seedlings.

FOOD-PLANTS.—Cucurbitaceous plants.

DESCRIPTION AND LIFE-HISTORY.—It is an orange-red beetle, about a quarter of an inch long, found commonly on leaves of melons, gourds, cucumbers, etc. (Fig. 9, Plate XLV). Its life-history has not yet been worked out.

REMEDY.—Dusting the plants with a mixture of wood-ash and lime, sprinkled with a little kerosine, is very effective.

Reference.—I. I. P., p. 201.

VIII.—VEGETABLES.

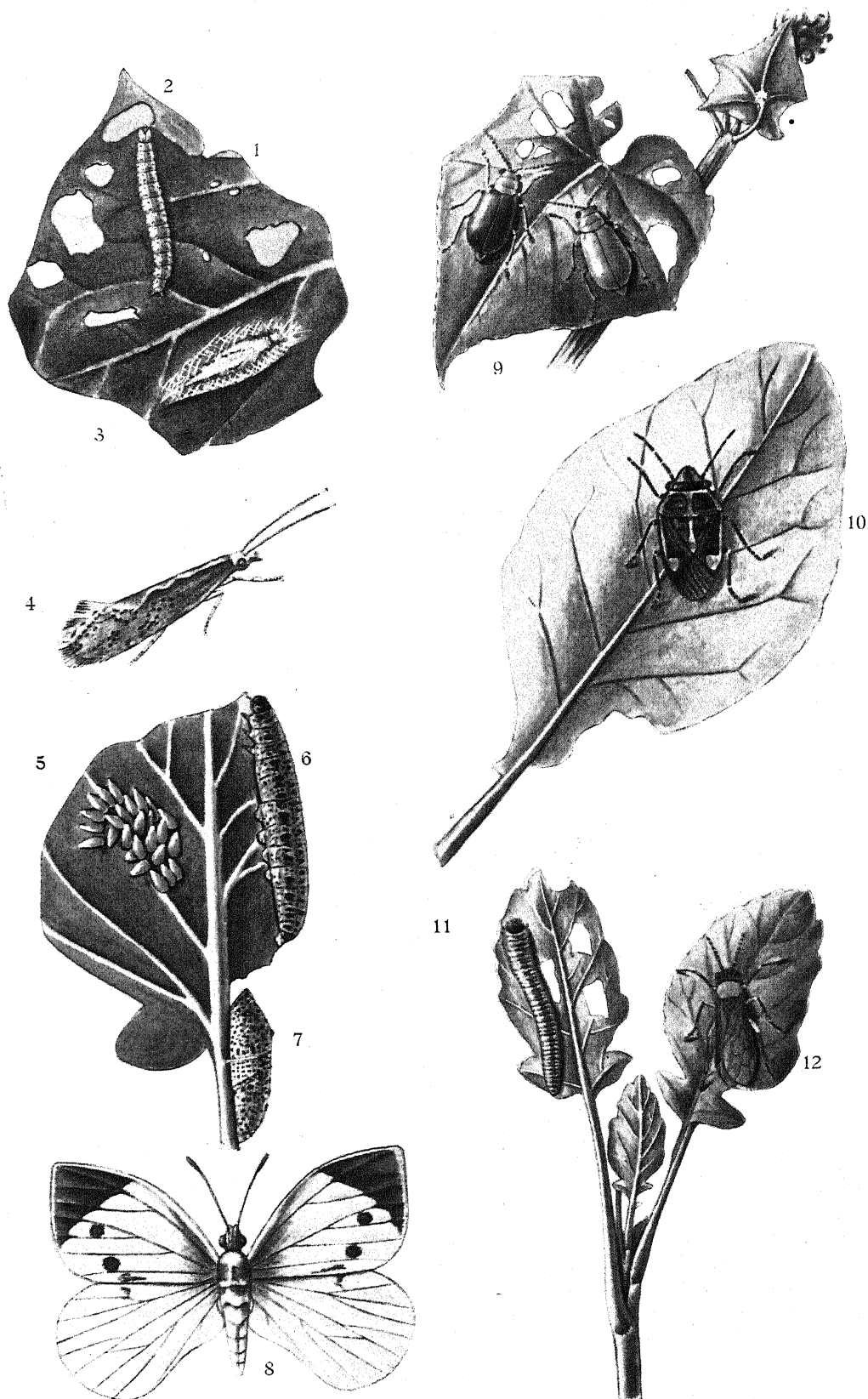
HOST : (B) PUMPKIN—*UCURBITA MAXIMA*.VERN. NAMES.—Beng.—*Bilati Kumra* ; Behari—*Kadima* ; Oriya—*Boitalu*.

PEST—

FUNGUS-MILDEW.—*Oidium* sp.

DESCRIPTION.—Mildew is a very common disease of Pumpkins, generally appearing somewhat late in the season when the plant is already weakened in vitality. It then causes the speedy death of the plant. The disease is characterised by the formation of a white powdery coating on the surface of the leaf and the stem. At first the disease starts in patches, but soon these patches enlarge and cover the whole of the leaves, and even the petioles and stems of the plant. The powdery substances contain the spores of the fungus which are produced in large quantities and are easily blown away and deposited on healthy leaves, causing a rapid spread of the disease.

REMEDY.—The attack is amenable to treatment, and sulphur dusting (*vide* Appendix No. XII) will give satisfactory results though it is usually hardly necessary.



PESTS OF VEGETABLE CROPS.

Fig. 1.—Eggs of Diamond back moth. Fig. 2.—Caterpillar of same. Fig. 3.—Pupa of same. Fig. 4.—Moth. Fig. 5.—Eggs of cabbage butterfly. Fig. 6.—Caterpillar of the same. Fig. 7.—Pupa of the same. Fig. 8.—Cabbage butterfly. Fig. 9.—Red and blue pumpkin beetles. Fig. 10.—Painted bug. Fig. 11.—Larva of mustard sawfly. Fig. 12.—Adult mustard sawfly.

VIII.—VEGETABLES.

HOST : C. CABBAGE AND CAULIFLOWER.—*Brassica oleracea*.

VERN. NAMES.—Beng.—*Bandha kapi*, *Phul kapi*; Hindi—*Bandha kobi*, *Phul kobi*; Oriya—*Bhandha kobi*, *Phul kobi*.

PEST—

(a) LEAF-EATING—

CABBAGE BUTTERFLY.—*Pieris brassica*, Linn.

NATURE OF DAMAGE.—The caterpillars of this butterfly feed on the leaves of cabbage and cauliflower. When abundant, they leave only the bare stalks of the leaves standing in the field.

LOCALITY AND TIME OF APPEARANCE.—It has been reported from Bhagalpur. It occurs all over Bengal. In Behar there are two broods—February to March and March to April.

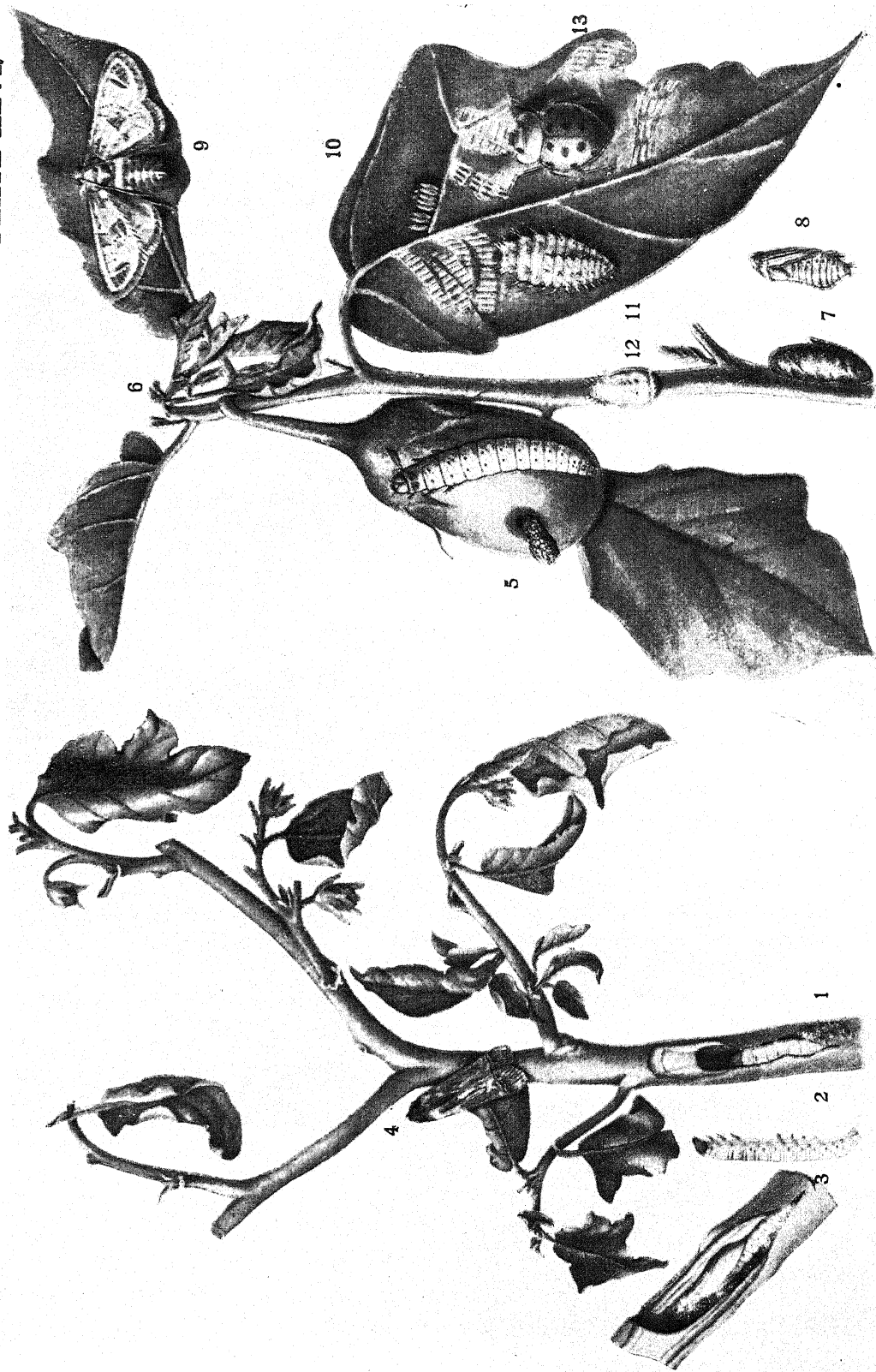
FOOD-PLANTS.—Cabbage, cauliflower and other cruciferous plants.

DESCRIPTION AND LIFE-HISTORY.—It is a big white butterfly with two black spots on its wings, and can be found flying about vegetable gardens during the day (Fig. 8, Plate XLV). A female butterfly lays a large number of eggs on the leaves of the food plants (Fig. 5, Plate XLV). These hatch in four or five days and small green caterpillars with black heads come out and start feeding on the leaves. In a fortnight, a caterpillar becomes full-grown, when it measures one inch and a half and is of a bluish-green colour with grey shades mingled with yellow (Fig. 6, Plate XLV). The body slightly tapers towards the ends. There are short white hairs on it. A full-fed caterpillar pupates either on a leaf or on a tree or any convenient place, with a girdle of silk round the middle to hold the chrysalid in position (Fig. 7, Plate XLV). The butterfly comes out of it within a week. This pest cannot do any serious damage to field crops, but it sometimes causes considerable loss in garden crops.

REMEDY.—Lead Chromate should be used on young plants only.

Tobacco decoction is also effective, and this should be applied to large plants which should not be treated with poison if they are required for table use.

Leaves with a large number of the young caterpillars should be picked off and destroyed.



PESTS OF BRINJAL.

Fig. 1.—Caterpillar of Brinjal stem borer inside the stem. Fig. 2.—The same removed from the stem. Fig. 3.—Pupa shown inside a piece of stem.
 Fig. 4.—Moth of same sitting on the stem. Fig. 5.—Affected Brinjal with fruit boring caterpillar on it. Fig. 6.—Drooping top shoot, having a fruit boring caterpillar inside it. Fig. 7.—Cocoon of the same. Fig. 8.—Pupa. Fig. 9.—Moth. Fig. 10.—Egg-cluster of *Epiplachna*. Fig. 11.—Grub of the same. Fig. 12.—Pupa of the same. Fig. 13.—Adult *Epiplachna*.

VIII.—VEGETABLES.

HOST : D. BRINJAL.—*Solanum melongena*.

VERN. NAMES.—Beng.—*Bégun* ; Hindi—*Baigan*, *Bhanta* ; Oriya—*Bāigana*, *Lamba Bāigna*.

PEST—

(c) BORING—

SHOOT AND FRUIT-BORER.—*Leucinodes orbonalis*, Guen.

STEM-BORER.—*Euzophera perticella*, Rag.

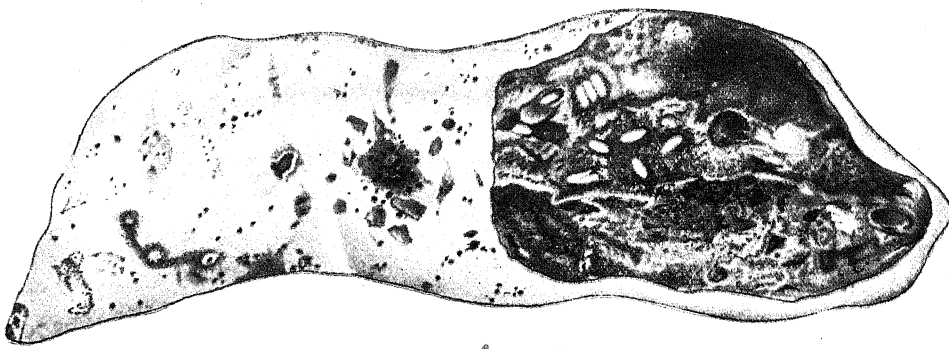
The brinjal plant suffers from two important caterpillar pests. These are the shoot and fruit-borer (*Leucinodes orbonalis*, Guen.) and the stem-borer (*Euzophera perticella*, Rag.).

FRUIT-BORER.—Sometimes the top shoots of a young brinjal plant are seen to drop down and wither (Fig. 6, Plate XLVI). Brinjal with black punctures on the skin are only too common (Fig. 5, Plate XLVI). These are caused by the caterpillars of the fruit borer. The female moth lays eggs on fruits or leaves and the young caterpillars on hatching bore either into the fruits or shoots as the case may be. They live and feed inside for a fortnight or so, then come out and pupate either on the plant or on the soil under dry leaves. The moth comes out of a pupa in five or six days (Fig. 9, Plate XLVI).

STEM-BORER.—When a brinjal plant is attacked by this pest it generally withers up or gets very stunted. If a dried-up plant be dug up and the stem opened and examined, a caterpillar will be found inside it (Fig. 1, Plate XLVI). It feeds on the tissues of the stem and kills the plants. When full-fed, it pupates in the tunnel (Fig. 3, Plate XLVI) and comes out as a moth (Fig. 4, Plate XLVI) after some days.

REMEDY.—The cultivators generally leave the affected brinjals on the plants or pick them and throw them away anywhere in the field. The dried-up plants are not cared for and are generally left standing on the fields. This should never be done as it allows the caterpillars to come out of the affected fruit or plant and infect healthy fruits and plants. The withered shoots, affected fruits and dried-up plants should be pulled off and burnt. If this is done carefully, the pests will very soon be brought under control.

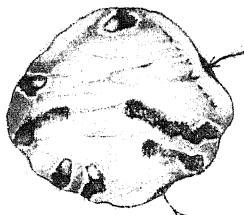
Reference.—I. I. P., pp. 165-167.



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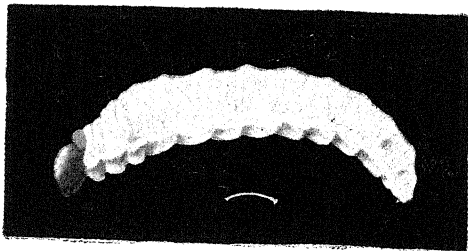


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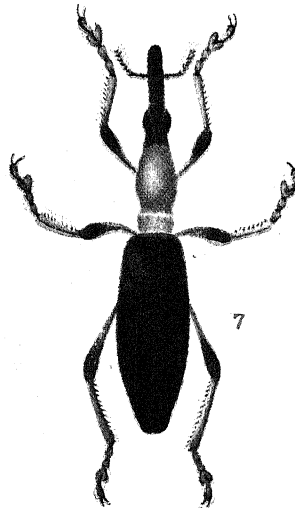


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SWEET POTATO WEEVIL.

Fig. 1.—Egg, magnified. Fig. 2.—Piece cut transversely to show eggs inside and tunnelling of grubs. Fig. 3.—Full-grown grub. Fig. 4.—Affected sweet potato with pupæ inside. Fig. 5.—Pupa from above, magnified. Fig. 6.—Pupa from below, magnified. Fig. 7.—Adult weevil, magnified. Fig. 8.—Antennæ of female and male weevils.

N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

VIII.—VEGETABLES.

HOST : F. SWEET POTATO—*Batatas edulis*.

VERN. NAMES.—Beng.—*Rāṅgē ālu*, *Sūdā ālu* ; Hindi—*Sakarkand*, *Kandū*,
Lamkā ālu, *āluū* ; Oriya—*Kandmāl*.

PEST—

(b) BORING—

SWEET POTATO WEEVIL.—*Cylas formicarius*, F.

NATURE OF DAMAGE.—When growing plants are tunnelled by the larvæ, the damage is not appreciable ; but when the sweet potatoes are tunnelled, they rot, and become useless for consumption. On cutting open an infested tuber, dark-coloured tunnels containing the insect's excreta will be found and also the different stages of the insect.

LOCALITY AND TIME OF APPEARANCE.—It probably occurs all over the province where sweet potato is grown. It has no regular fixed season as it can find its food almost all through the year.

FOOD-PLANT.—Sweet potato.

DESCRIPTION AND LIFE-HISTORY.—It is a small steel-blue weevil, about one-third of an inch long, with a prominent snout (Fig. 7, Plate XLVII). The female weevil bites out a small hole in the tuber with its jaws and lays elongate and creamy white eggs in it, generally one in each hole (Figs. 1, 2, Plate XLVII). Eggs may also be laid on the thick stems of the plant. A grub, on hatching, eats its way into the tuber or stem, as the case may be, and feeds on the tissues inside. A full-grown grub is about a quarter of an inch long, of a pale yellow colour with a soft legless body and a dark brown head (Fig. 3, Plate XLVII). In a badly infested sweet potato several hundred such grubs may be found (Fig. 4, Plate XLVII). When full-grown, a grub eats out a rounded chamber inside the tuber and pupates in it (Figs. 4, 5, 6, Plate XLVII) from which the adult weevil emerges in a short time.

REMEDY.—The best preventive is to keep the potatoes in the field well covered with soil, so that direct egg-laying cannot take place.

Infested potatoes should be destroyed as soon as the crop is dug and should, on no account, be allowed to lie exposed in the fields.

Sweet potatoes should not be grown twice running on or near infested land. Moderately infested potatoes can be fed to cattle in small quantities after boiling.

Reference.—Mem. D. Ag. I., Vol. II, No. 8 (Ent. Series), Life-histories of Indian Insects (Coleoptera I), by H. M. Lefroy.

I. I. P., p.p. 163-164.

VIII.—VEGETABLES.

HOST : G. ARUM—*Colocasia antiquorum*.VERN. NAMES.—Beng.—*Kachu* ; Behari—*Kachu* ; Oriya—*Kachu*.

PEST—

FUNGUS.—*Phytophthora Colocasiæ*, Racib.

DESCRIPTION.—This disease is very common on both the wild and cultivated varieties of *kachu*. It is at first marked by very small dark brown specks on the leaf out of which ooze minute drops of a yellowish liquid. The spots gradually enlarge into big brown blotches which are either more or less circular or irregular in shape, sometimes covering the greater portion of the leaves. (*Vide* Plate XLVIII). On the edges of these blotches careful examination with a lens may show the presence of a greyish downy coating containing the fruit of the fungus. The spread of the disease and the extent of the damage are largely determined by the weather conditions, damp cloudy weather with occasional showers of rain being most favourable for the attack, which in extreme cases affects all the leaves and passes down along the petiole even into the rootstock. Consequently in such cases the crop fails and the corm either rots away or remains very small and ill-formed.

REMEDY.—The disease probably remains in the rootstock and breaks out every year with the new crop. Selection of healthy seeds may, therefore, be useful.

IX.—FRUITS.

HOST : A. MANGO—*Mangifera indica*.

VERN. NAMES.—Beng.—*Am* ; Hindi—*Am* ; Oriya—*Amba*.

PEST—

(a) SUCKING—

SMALL MANGO-LEAF HOPPER.—*Idiocerus clypealis*, Leth.

NATURE OF DAMAGE.—This small insect, in its adult and young stages alike, sucks out the juice of the growing shoots and leaves of mango trees with its small beak. When abundant, the amount of drain on a tree is so great as to cause a loss of the whole crop of fruit.

LOCALITY AND TIME OF APPEARANCE.—It is common practically all over Bengal. It becomes abundant in the hot weather and specially so at the flowering season when there is a large amount of sap in the flowering shoots.

FOOD-PLANT.—Mango.

DESCRIPTION AND LIFE-HISTORY.—It is a dark grey wedge-shaped insect, about one-sixth of an inch long, with a small beak. The wings are sloped at an angle over the back. The insects are generally found in large numbers on the undersides of the leaves and on young shoots ; when disturbed, they fly about for some time and again gather on another leaf. In March or April the female hopper lays eggs in the tissues or growing shoots. On hatching, the wingless young ones suck out the sap like the adults. They exude a kind of sugary liquid which falls upon the leaves below and dries, leaving a sticky shiny deposit. These leaves turn black in a few days on account of the growth of a mould on them.

REMEDY.—Spraying with strong Crude Oil Emulsion (1 in 25) is the only effective treatment (See Appendix No. IV).

Reference.—I. I. P., p. 173.

IX.—FRUITS.

HOST: A. MANGO—*Mangifera indica*.VERN. NAMES.—Beng.—*Am* ; Hindi—*Am* ; Oriya—*Amba*.

PEST—

(b) FRUIT-BORING—

MANGO AND PEACH-FLY.—*Dacus persicæ*, Rig.

NATURE OF DAMAGE.—When a mango or peach is cut open, small white maggots are sometimes seen wriggling in the pulp. These are the maggots of the fruit fly which render the fruits useless.

LOCALITY AND TIME OF APPEARANCE.—Its attack on peach has been reported from Bhagalpur. Attacked mangoes are common in Lower Bengal. Its activity begins when the mango crop begins to ripen.

FOOD-PLANTS.—Mango and peach.

DESCRIPTION AND LIFE-HISTORY.—It is a red-brown fly, with black and yellow markings on the body, of the size of an ordinary house-fly. The female fly lays long white eggs just under the skin of the fruit by means of the long horny process at the hind end of its body. The eggs are generally laid in wounds on the skin. When these hatch, in two or three days the young maggots tunnel into the fruit and feed on the tissues. A maggot generally passes ten to fifteen days inside the fruit, when it becomes full-grown. It is then that it leaves the fruit, falls to the ground, and pupates in the soil. After about a week, it comes out as a fly.

REMEDY.—Once the eggs have been laid, practically nothing can be done. The increase of the pest can, however, be checked in the following way :—Every fruit that falls from the tree and every fruit that is found to be infested, should be destroyed. Particular care should be taken to collect the early infested fruits, as this would prevent the flies from emerging and laying their eggs on fresh fruits.

Hanging up “Tangle foot” papers smeared with Citronella Oil attracts the males. After rain in the fruiting season (April and May), the male flies emerge and they may be caught in the above way.

Cultivation round trees also does good by destroying the pupæ.

Reference.—I. I. P., pp. 170—172.

IX.—FRUITS.

Host : A. MANGO—*Mangifera indica*.

VERN. NAMES.—Beng.—*Am* : Hindi—*Am* ; Oriya—*Amba*.

PEST—

(b) FRUIT-BORING—

NORTHERN MANGO WEEVIL—*Cryptorhynchus gravis*, F.

NATURE OF DAMAGE.—The grubs of this weevil spoil mango fruits by tunnelling into the pulp and the stone. When an affected mango is cut open, any adult weevil that may be inside it flies away with a buzzing sound.

LOCALITY AND TIME OF APPEARANCE.—This pest is common in Purneah district and some other parts of Bengal. It appears in the mango season.

FOOD-PLANT.—Mango (fruits).

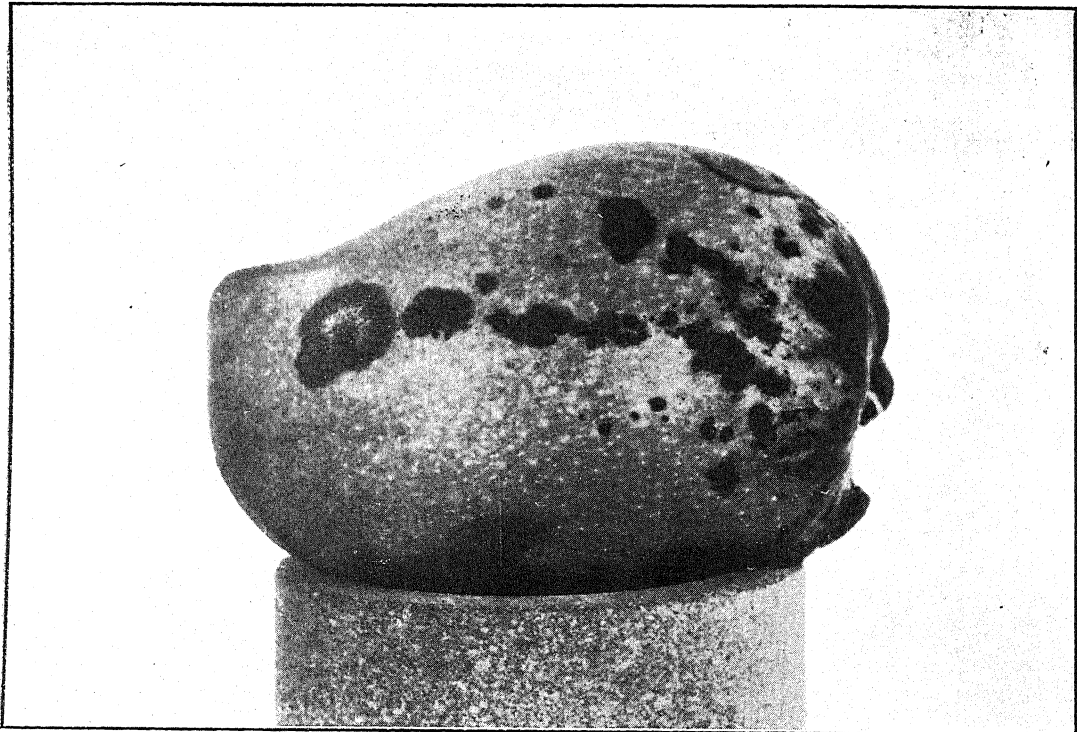
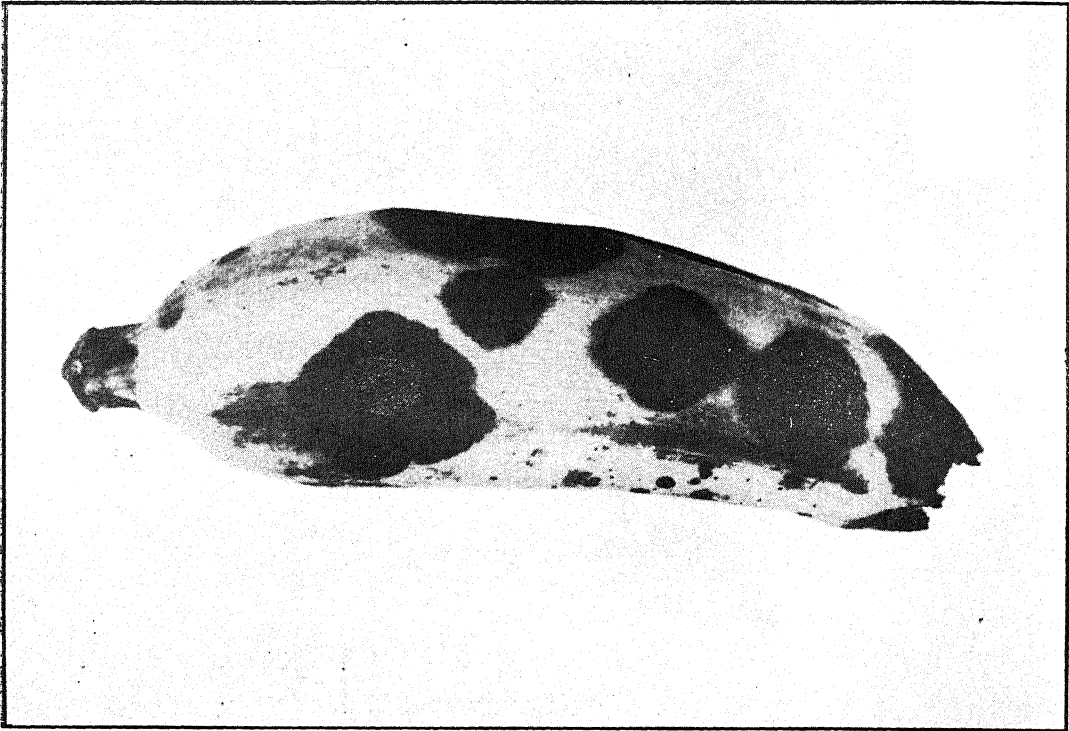
DESCRIPTION AND LIFE-HISTORY.—It is a small, dark-brown weevil, with a thick set body, about one-third of an inch long. The female weevils lay eggs on the newly formed mango fruits. The grubs on hatching bore into the fruits by cutting through the skin, and the wounds heal up very soon leaving no scar on the outside. A grub feeds on both the pulp and the kernel, and when full-fed, pupates inside. When an adult beetle comes out of the pupa, it cuts its way out of the fruit. It has only one brood in the year and the adult beetle after coming out of a fruit hides in the bark of the affected tree, either in its natural cracks or in holes made by itself ; it may also remain hidden in the soil below. It remains there in this condition till the next fruiting season. One peculiarity of this pest is that it attacks the fruits of the same tree year by year.

REMEDY.—The affected fruits should be destroyed to prevent the weevils coming out.

The trunk of the tree which bears infested mangoes should be washed well with strong kerosine emulsion to kill the adult beetles on it.

Cultivation of the soil round the base of the tree and irrigation help to kill the adult beetle in the soil.

Reference.—I. I. P., p. 174.



RIPE ROT OF FRUITS (*Glaosporium* spp.)

IX.—FRUITS.

HOST : RIPE FRUITS.

PEST—

FUNGUS.—RIPE ROT—*Gloeosporium*—various species.

DESCRIPTION.—Many ripe fruits such as mango, banana, jack, tomato, etc., are liable to an attack of rot which is brought about by several species of the above fungus : and if the fruits are stored in a common place in contact with one another, considerable damage may be expected to result. The disease first appears as very minute black spots on the surface of the skin of the fruit. These quickly enlarge (Plate XLIX), while the tissues below the spots undergo disorganization in consequence of which the spots become somewhat depressed. In severe attacks a considerable portion of the fruit is thus damaged. In the course of a few days the depressed spots become studded with more or less concentric pinkish raised spots, or dots of the size of a pin's head. These contain the spores of the fungus which are produced in large quantities and which spread the disease by coming in contact with fresh fruits.

REMEDY.—In order to prevent the spread of the disease, all diseased fruits should be separated from the healthy ones as soon as the smallest traces of the black spots are noticeable.

IX.—FRUITS.

HOST : A. MANGO—*Mangifera indica*.VERN. NAMES.—Beng.—*Am* ; Behari—*Am* ; Oriya—*Ambla*.

PEST—

FUNGUS—BLACK BLIGHT.—*Capnodium Mangiferum*, Cke.

DESCRIPTION.—It is a very common disease of the mango leaves, and though it causes damage to the plant by interfering with the proper function of the leaves, no notice is usually taken and the disease is allowed to spread until almost all the leaves are attacked and the plants severely damaged. The fungus forms a thin black incrustation on the surface of the leaves which in dry weather cracks and peels off, exposing the normal surface of the leaves. The fungus is not parasitic on the leaves, but grows saprophytically on the sugary secretions of certain insects which occur on these trees. [*Vide* small mango leaf-hopper, No. (a) above.] Hence the damage which it does to the plants is of an indirect nature.

REMEDY.—The best means of preventing the disease is to attack the insects which secrete the sugary substances and thus tempt the fungus to grow. For this purpose resin wash (*vide* Appendix No. XIII) is said to be a satisfactory remedy.

IX.—FRUITS.

HOST : D. POMEGRANATE—*Punica granatum*.

VERN. NAMES.—Beng.—*Dārim*, *Dālim* ; Hindi—*Anār* ; Oriya—*Dālimba*.

PEST—

(a) IN FRUIT—

ANAR CATERPILLAR.—*Trachola isocrates*, F.

NATURE OF DAMAGE.—The caterpillars of this butterfly bore into the Anar fruits and feed on the hard seeds.

LOCALITY AND TIME OF APPEARANCE.—It is common almost all over Bengal. Some reports about its damage have been received from Behar. It generally appears when the Anar trees blossom.

FOOD-PLANTS.—Pomegranate, loquat, guava, *Randia dumetorum*.

DESCRIPTION AND LIFE-HISTORY.—It is a medium-sized butterfly, about one inch across the wings, which are deep violet and glossy on the upper side. When the Anar trees blossom, the female butterfly deposits eggs singly on the flowers. A caterpillar, on hatching, bores into the developing fruit within which it lives. A caterpillar is of a dark colour with short hairs and with lighter patches of colour and with the hind end flattened above. A full-grown caterpillar measures about three-fourths of an inch. When full-fed, the caterpillar comes out of the fruit, webs silk at the base and stalk of the fruit to prevent it falling to the ground, and then enters the fruit again to turn into a chrysalis. The butterfly emerges from the chrysalis in a short time.

REMEDY.—It is difficult to check this pest as the young ones live inside the fruits, but the butterflies can be collected with hand nets and killed. This is in fact the only way by which the pest can be kept under control.

A rather expensive method is to tie bags round the fruits just after pollination so that the butterflies may not lay eggs on them.

Every affected fruit should be picked off and destroyed either by burning or by burying in the ground. If allowed to remain, butterflies would come out of the chrysalides in them and affect fresh fruits.

Reference.—I. I. P., pp. 179-80.

IX.—FRUITS.

HOST : E. ORANGE, ETC.—*Citrus Spp.*

PEST—

(a) LEAF-EATING—

LEMON CATERPILLAR.—*Papilio demoleus*, L.

NATURE OF DAMAGE.—The caterpillars of this butterfly feed on the leaves of lemon, orange trees, etc., and, if abundant, entirely strip them.

LOCALITY AND TIME OF APPEARANCE.—It is present all over Bengal and is found almost throughout the year.

FOOD-PLANTS.—Citrus plants, *Bael* (*Aegle marmelos*), *Ber* (*Zizyphus jujuba*).

DESCRIPTION AND LIFE-HISTORY.—It is a large and conspicuous butterfly, with black and lemon yellow marks on its wings and with two blue eye-like marks on the hind wings (Figs. 9-10, Plate L). A female butterfly lays eggs singly on the leaves of food-plants (Fig. 1, Plate L). A caterpillar, on hatching, feeds openly on small leaves, attacking larger ones as it grows older. A young caterpillar is brown with white markings, and closely resembles the droppings of birds (Figs. 2-5, Plate L), but when full-grown, the colour changes to a vivid green with brown markings (Fig. 6, Plate L). When full-fed a caterpillar pupates on the plant with a girdle of thread round its body (Figs. 7-8, Plate L). After a few days, the butterfly comes out of the chrysalis.

REMEDY.—The simplest method is to pick off the caterpillars and destroy them.

Reference.—I. I. P., pp. 175-176.



SOOTY MOULD OF CITRUS FRUITS (*MELIOLA* SPP.)

IX. —FRUITS.

HOST : E. ORANGE—*Citrus aurantium*.

VERN. NAMES.—Beng.—*Kamlanabu* ; Behari—*Narangi* ; Oriya—*Kamlu*.

POMELO—*Citrus decumana*.

VERN. NAMES.—Beng.—*Batabi nabu* ; Behari—*Mahtabi nabu* ; Oriya—*Kandhia nembu*.

LEMON—*Citrus medica*, var. *Acida*.

VERN. NAMES.—Beng.—*Patinabu* ; Behari—*Nimbo* ; Oriya—*Kajji nembu*.

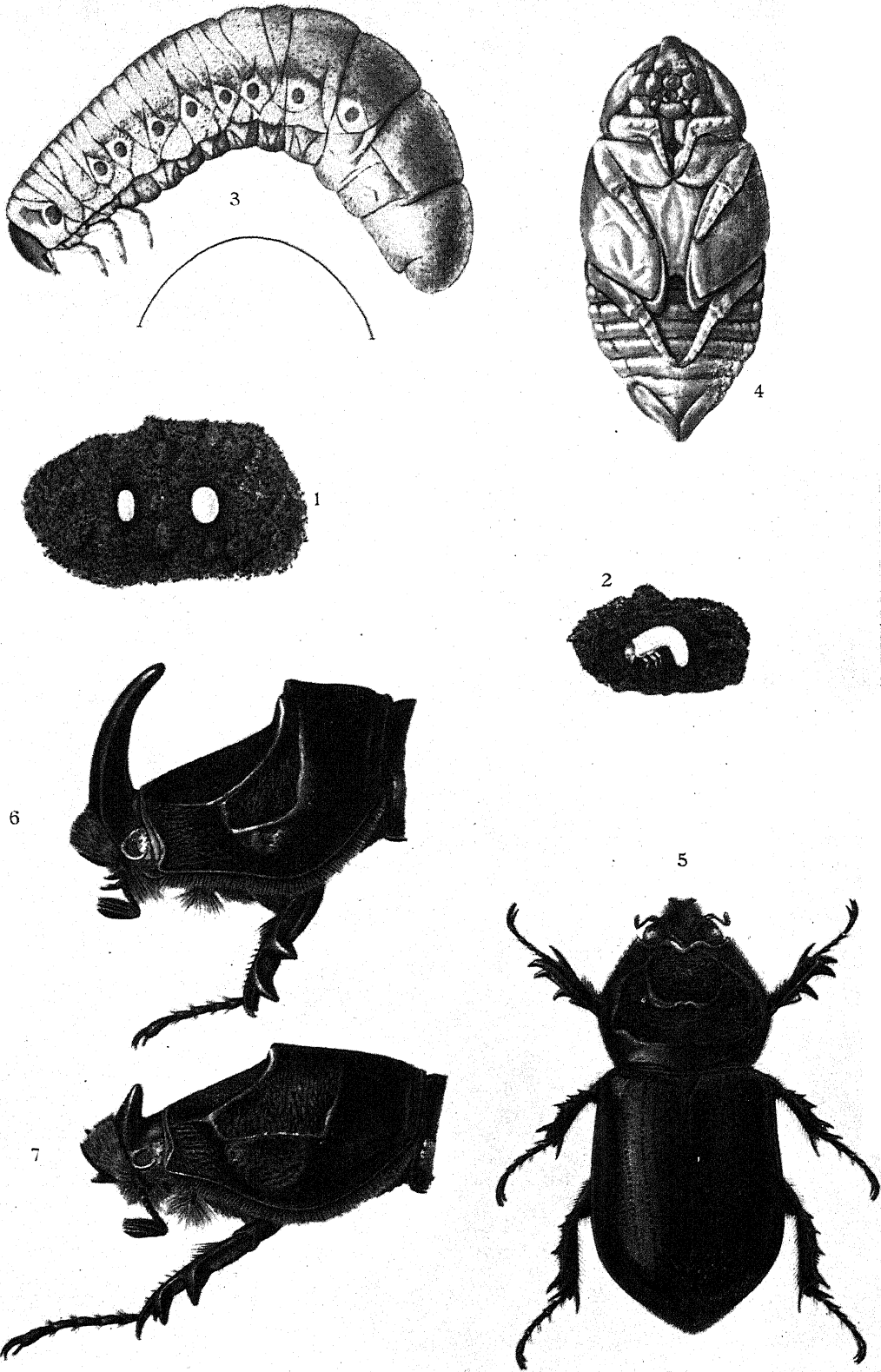
PEST—

FUNGUS—

SOOTY MOULD.—*Meliola*, various species.

DESCRIPTION.—The disease is very common on the leaves and the young stems of the above trees, and although it usually passes unnoticed, it does not fail to do a certain amount of damage by interfering with the proper function of the leaves and the stems. The fungus is not parasitic on the plants, but merely forms a thick black incrustation by the interweaving of the mycelial threads which cover the surface of the leaves and stems, and thus mechanically injure the plants by preventing the light from reaching the leaves. The fungus is induced to grow on the leaves and stems of the plants by the sugary secretions of certain insects which occur parasitically on these plants.

REMEDY.—The best method to check the sooty mould is to destroy the insects which secrete the sugary substances. This has been successfully done by resin wash (*vide* Appendix No. XIII), which may be applied.



RHINOCEROS BEETLE.

Fig. 1.—Eggs. Fig. 2.—Young grub. Fig. 3.—Full-grown grub. Fig. 4.—Pupa. Fig. 5.—Adult beetle. Figs. 6 & 7.—Horns on the head of adult beetles.
N.B.—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

X.—PALMS.

HOST : A. PALMYRA PALM & COCOANUT PALM—*Borassus flabellifer*
and *Cocos nucifera*.

VERN. NAMES.—Beng.—*Tal*, *Narikel* ; Hindi—*Tar*, *Narial* ; Oriya—*Tala*
Naria, *Daba*.

PEST—.

(a) INSECT-BORING—

RHINOCEROS BEETLE.—*Oryctes rhinoceros*, L.

VERN. NAMES.—*Gobare poka*—L. Bengal ; *Bhomra poka*—L. Bengal.

NATURE OF DAMAGE.—The beetle feeds on the soft tissues of the palms, eating its way through the unopened leaf or the base of the fruiting stem into the soft heart of the tree, the ultimate result being the death of the tree. An attacked tree is generally denuded of its graceful crown, the leaves appearing ragged with large holes and in young trees there is generally a large hole visible near the base of the leaf-stalks with fibres and debris protruding and a gummy substance exuding. The yield of toddy also decreases as a result of the attack.

LOCALITY AND TIME OF APPEARANCE.—It occurs practically everywhere in Lower Bengal where cocoanut palms are grown. The beetles are generally found from March to October.

FOOD-PLANTS.—Palmyra palm, cocoanut palm.

DESCRIPTION AND LIFE-HISTORY.—The rhinoceros beetle is a large thick set black beetle, somewhat over two inches long and one inch broad (Fig. 5, Plate LII). Each female lays about 10 eggs. The eggs are of a creamy colour, oval, laid in dung heaps or in any decaying vegetable matter (Fig. 1, Plate LII). The grub, on hatching, goes on feeding on the decomposing vegetation and remains in it until it is quite mature (Fig. 2, Plate LII). It is a large soft white legless larva, resembling in external appearance the chafer grubs, being about 4 inches long and $\frac{3}{4}$ inch broad, with 3 pairs of legs, powerful jaws and curved body (Fig. 3, Plate LII). The grub is not injurious to young plants unless it can get inside them. It generally lives in this stage for a considerable period and then pupates in an earthen chamber when in the soil or a manure heap, or in a rough cocoon of fibre, if it is in some fibrous mass. The beetle comes out of this and goes out to attack the palm at the crown. The male has a distinct horn (Fig. 6, Plate LII) and the female only a knob (Fig. 7, Plate LII). The beetle flies at night and bores into the palm tree through the base of the leaves

and fruiting stems, burrowing some distance downwards from the top and making a nest inside in which to hide during the day time. It comes out again after dusk to feed.

REMEDY.—Rubbish or other decomposing matter should not be allowed to accumulate in the vicinity of the palm trees as the beetle lays eggs on it and breeds close by. Care should also be taken to prevent the beetles breeding on manure heaps.

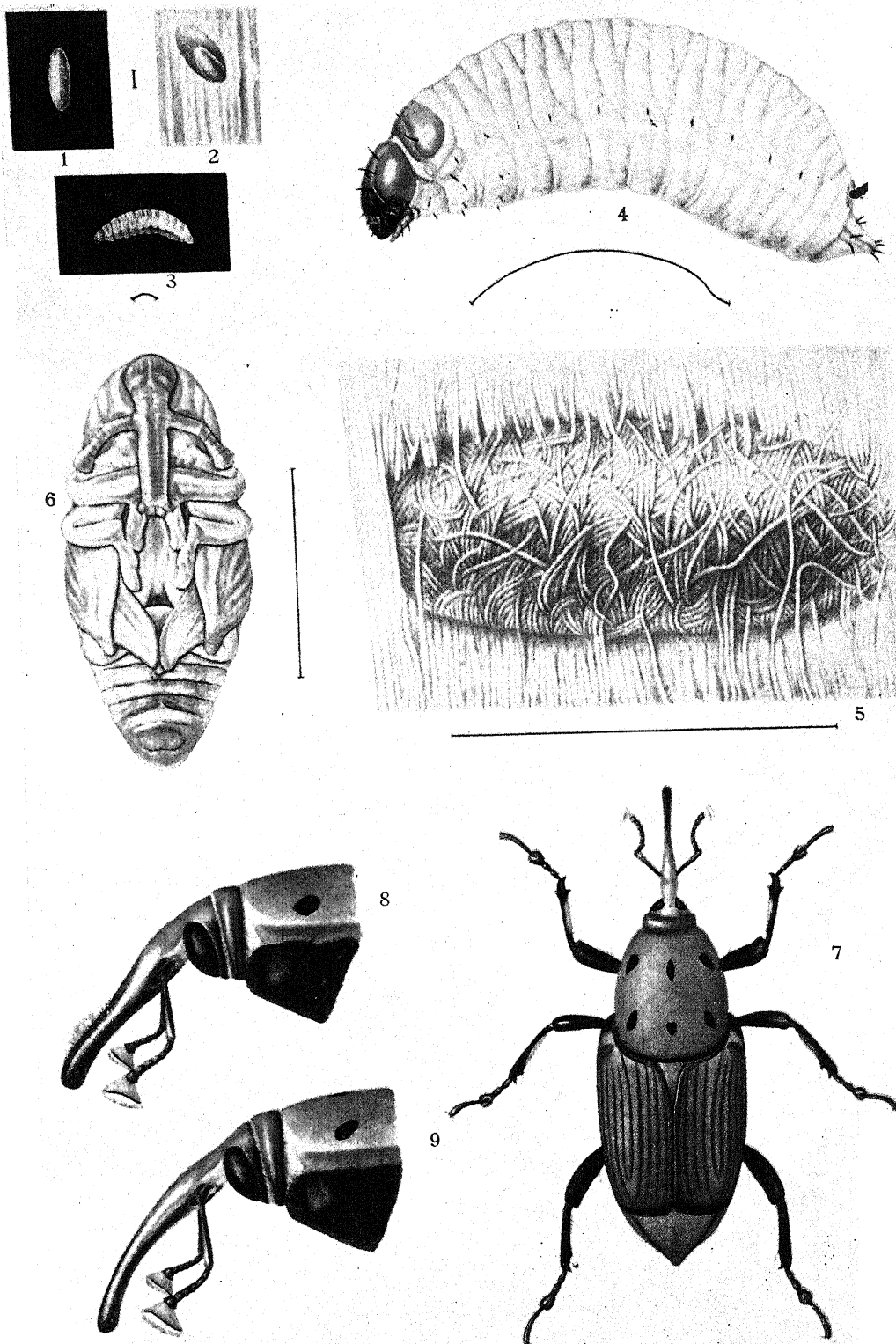
Since the beetles are attracted to light, small bonfires near the trees might be successful in destroying a considerable number of these beetles.

Whenever there are indications of the attack, all holes on the crown should be probed with a stiff arrow-headed wire and any beetles speared should be drawn out and killed. The holes should be closed by Tar or Crude Oil emulsion mixed with clay, as there is another more serious pest of palms, the Palm Weevil, which is likely to get in through them and do an even greater amount of damage.

Destroy every palm tree that dies of this pest.

References.—I. I. P., pp. 207-208.

Mem. D. Ag. I, Vol. II, No. 10 (Ent. Series), Life-histories of Indian Insects III, by C. C. Ghosh.



PALM WEEVIL.

Fig. 1.—One egg. Fig. 2.—Egg inside a cavity in the stem. Fig. 3.—Young grub, one day old. Fig. 4.—Full-grown grub. Fig. 5.—Cocoon inside the stem. Fig. 6.—Pupa. Fig. 7.—The adult weevil. Fig. 8.—Snout of the male. Fig. 9.—Snout of the female. *N.B.*—In cases where the insects have been drawn larger than life size, the hair lines beside them indicate their natural size.

X.—PALMS.

HOST : B. DATE PALM—*Phoenix sylvestris*.

VERN. NAMES.—Beng.—*Khejur*, *Khajur*. Hindi—*Khajūr*; Oriya—*Khejura*.

PEST—

(a) INSECT-BORING—

PALM WEEVIL.—*Rhyachophorus ferrugineus*. Oliv.

NATURE OF DAMAGE.—The grubs of this weevil enter a palm tree through the soft tissues of the crown and gradually tunnel down into the stem, the result being the death of the tree. It is a serious pest of date palms.

LOCALITY AND TIME OF APPEARANCE.—It is reported from Bhagalpur and occurs more or less in other parts of Bengal where date trees grow. It generally attacks the trees during the tapping season.

FOOD-PLANTS.—Date palm, cocoanut palm.

DESCRIPTION AND LIFE-HISTORY.—The Palm Weevil is a moderate-sized insect, about $1\frac{1}{2}$ inches long of a red-brown colour, with a conspicuous curved snout (Fig. 7, Plate LIII). The female weevil lays eggs singly in the tender tissues of the palm tree inside the wounds made by the rhinoceros beetle, or in cuts made by tapping, or at the base of the leaf stalk (Figs. 1, 2, Plate LIII). An egg is about $\frac{1}{8}$ th inch long. The grubs on hatching tunnel into the soft tissues, feed on them and gradually work down into the stem. They have no legs, are soft-bodied, wrinkled and slightly curved (Figs. 3, 4, Plate LIII). Many may be found on the same tree. When full-fed the grubs prepare a cocoon of the palm fibres with openings at both ends and pupate inside (Fig. 6, Plate LIII). After about three weeks the adult weevils emerge. They fly about at night and remain in hiding during the day. They are pretty common from March to June.

REMEDY.—Egg-laying by these weevils should always be prevented; this can be done by closing up all cuts (generally made in the tapping season) and wounds (from the attack of the rhinoceros beetle) by tar or sand plaster; in fact, all openings should be closed to prevent the weevil reaching any tender tissue on which to lay its eggs.

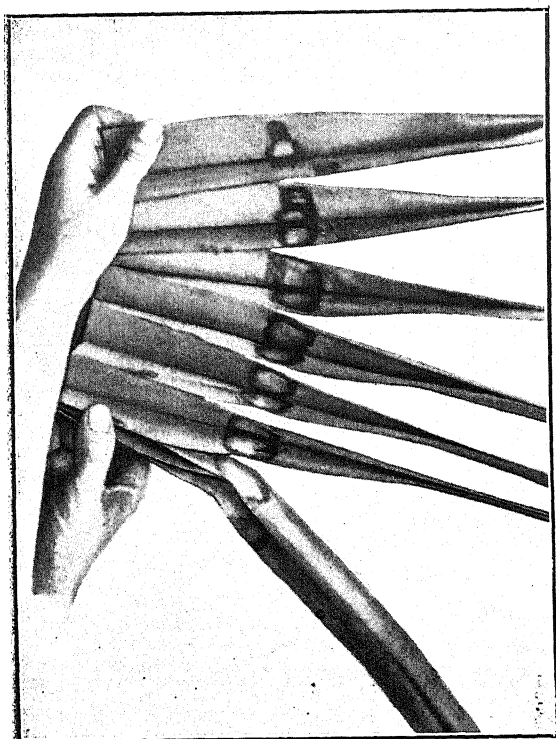
The green leaves should not be torn off in warm weather carelessly as such wounds give a good egg-laying place for the weevil.

A badly attacked tree should always be cut down and burnt. In the case of slightly attacked trees, the grubs should be cut out or killed with carbon bisulphide, any wounds being treated with tar.

References.—I. I. P., pp. 208-209.

Mem. D. Ag. I, Vol. II, No. 10, Life-histories of Indian Insects
III, by C. C. Ghosh.

PLATE LIV.



Spots on Leaf-blade.



Spots on Leaf-sheath.



Palms attacked by Bud Rot.

BUD ROT OF PALMS (*Pythium palmivorum*.)

X.—PALMS.

HOST : A. PALMYRA PALM—*Borassus flabellifer*.

VERN. NAMES.—Beng.—*Tal*; Behari—*Tar*; Oriya—*Talu*.

B. COCOANUT—*Cocos nucifera*.

VERN. NAMES.—Beng.—*Narikel*; Behari—*Narial*; Oriya—*Naria*.

C. BETELNUT—*Areca catechu*.

VERN. NAMES.—Beng.—*Supari*; Behari—*Supari*; Oriya—*Supari*.

PEST —

FUNGUS BUD-ROT.—*Pythium palmivorum*, Butl.

DESCRIPTION.—This serious disease of the Madras Presidency on areca nut, coconut, and chiefly on palmyra palm is probably unknown in Bengal. But as the host plants occur largely in this province, a brief account of the disease may be useful. The chief symptom of the disease, as the name implies, is a rot set up in the bud in consequence of which the crown withers and falls off (Plate LIV). The earliest symptom of the attack is the withering of one of the youngest leaves towards the centre; other adjacent leaves are attacked which in turn also wither until the whole crown is thus affected and ultimately falls off, leaving a bare stump standing. On examination the bud is found to be thoroughly rotten and disorganized, giving out a very foul smell. If the leaf sheath is examined, the fungus is found to have produced depressed patches on it which contain white fluffy masses of the fungus threads. The fungus also attacks young leaves on which it produces a pinkish discolouration (Plate LIV). The disease is of a serious nature and its spread has produced disastrous effect on the growers of these palms in Madras.

REMEDY.—It has been found necessary in Madras Presidency to cut out all suspected plants to save the healthy ones.

Reference.—Mem. D. Ag. I (Bot. Series), Vol. III, No. 5, The Bud-rot of Palms in India, by Dr. E. J. Butler.

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XI.—STORE PESTS.

The Life-histories of the more important insect pests, affecting grain. etc., stored in godowns, are given below :—

The Pests are—

- (1) RICE WEEVIL—*Calandra oryzae*, L.
 - (2) PEA BEETLE—*Bruchus chinensis*, L.
 - (3) RICE SEED MOTH—*Sitotroga cerealella*, Ol.
- (1) RICE WEEVIL : CALANDRA ORYZAE, L.—It is a minute dark-coloured insect with a prominent snout. It attacks stored wheat, rice, etc., in godowns. The female weevil makes a minute hole in a grain with its jaws and then lays an egg in it, only one in each grain. On hatching, the grub bores into the grain and feeds inside it, hollowing out the interior, but keeping the outer skin intact. The young one is a fleshy white grub with a curved body. When full-fed, it pupates inside the grain and eventually comes out as an adult weevil.
 - (2) PEA BEETLE : BRUCHUS CHINENSIS, L.—This beetle is a distinct pest of pulses. The female beetle lays small scale-like eggs on dried pulses. The young grubs, on hatching, bore into the grains, hollow them out and feed on their substance. When full-fed, a grub first cuts a small round disc on the skin of the grain, but not detached from it, for the adult beetle to come out. Then it pupates inside the grain and comes out in time through the opening as an adult beetle.
 - (3) RICE SEED MOTH.—SITOTROGA CEREALELLA, Ol. It attacks stored paddy, maize, etc. Eggs are laid by female moths on grains. On hatching, a caterpillar eats its way into the grain and lives there till full-fed, when it transforms into a pupa inside the empty husk. The moth comes out of the pupa in eight to ten days.

REMEDY.—The following preventatives and remedies will apply to the three above cases :—

- (1) Cleanliness should be observed strictly in seed godowns. The room should be washed at least once a year.
- (2) Seeds should be thoroughly dried before storing.
- (3) Seeds should always be stored in air-tight bins. If kept in open vessel, the insect will appear sooner or later and lay eggs on the grain. When stored in an earthen "goli" or "jala," the opening should be covered

with a lid and made air-tight by plastering it up with mud, so that no insect may get access into the vessel. When placed in a good iron bin, the underside of the lid and the rims of the box should be so padded that when the lid is closed, there would be no opening in it for an insect to get in.

- (4) Fumigate (*see* Appendix No. V) every seed with carbon bisulphide, before storing it in the godown and also whenever it is found to be attacked by insects. Fumigation will destroy the insects in the seed without affecting its power of germination.

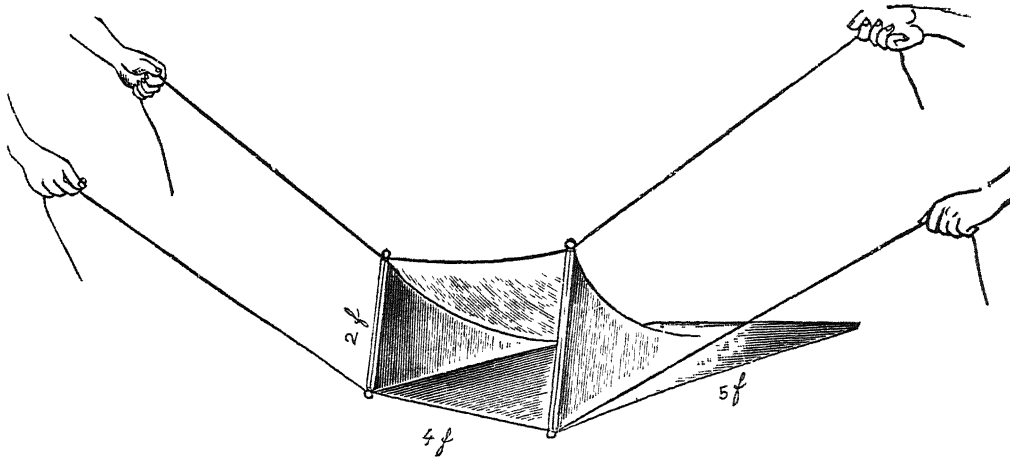
References.—I. I. P., pp. 251—260.

B. Q. J., Vol. V, No. 11, pp. 156—162.

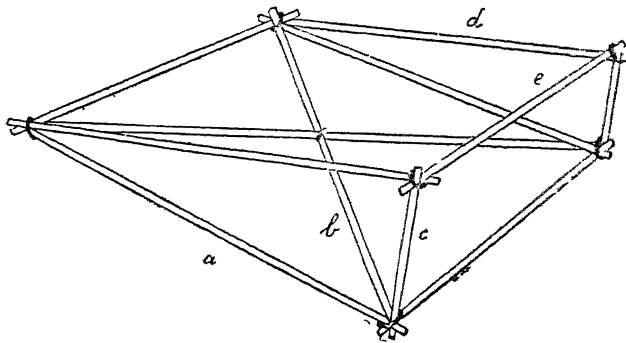
APPENDIX I.

BAGGING.

1. An insect bag is an invaluable help to a cultivator if he uses it properly and in time. In order to make a bag of dimensions four feet by two feet, select some coarse strong cloth fourteen feet long and six feet wide. Bring the two ends together and sew up the sides. Then make a rectangular bamboo frame two feet by four feet and fix it



in the opening of the flat bag to keep it open. The opening of the bag may be made smaller or larger according to requirements. The depth of the bag also depends upon its use; if the bag is to be pulled over bare ground it would not matter if it is seven or eight feet deep, but for pulling over crops it should be short so that it may not hang too much



on the plants. A medium sized bag can be worked easily by two coolies, one on each side, holding the projecting handles of the bamboo frame or ropes tied at each corner. A large

number of insects will be caught in it if it is run rapidly across an affected field, the insects inside should be killed by twisting up the bag at the end of each sweep. In this way an affected area can be completely cleared off in a short time. For catching the small leaf hoppers it is better to smear the inside of the bag with kerosine or some heavy oil. When the bag is used alone two feet long bamboos may be inserted instead of the frame as in the first illustration. It may, however, be attached to the frame as in the second illustration and used similarly, the twisting being done by taking off the frame at once.

APPENDIX II.

SPRAYER.

By spraying is meant throwing upon plants any fluid or semi-fluid in the form of a fine mist so that it may cover the parts of plants to be protected, leaves, etc., with a thin but uniform film of a material that is either poisonous, offensive or caustic to the pest which it is intended to destroy ; and the machine by which this is accomplished is known as a sprayer or spraying machine. Spraying machines are not usually of much assistance in India except where particularly valuable crops have to be preserved. There are different kinds of spraying machines, but the "Success Knapsack Sprayer" is the most useful pattern for general work. This can be obtained from Messrs. Wilkinson, Heywood and Clarke & Co., Oriental Buildings, Bombay, at a cost of Rs. 60 each. It consists of a copper reservoir (capacity 4 gallons) fitted with a pump and an air chamber. A nozzle at the end of the rubber-tubing attached to the pump, breaks up the ejected liquid into a fine mist. There is a strainer at the top of the reservoir for pouring in the liquid. One cooly can carry the machine on his back, work the pump with his left-hand and do the spraying by directing the nozzle with his right. It can also be used on the ground when the short handle should be used.

A machine should be thoroughly cleaned and clean water pumped through the tube after use. Insecticides should be poured into it only through the strainer.

Where a spraying machine is not available a garden syringe with a fine rose nozzle may be used with some success.

APPENDIX III.

LEAD CHROMATE.

Two types of mouth parts are to be found in the insect world, biting and sucking. Insects with biting mouth parts feed on leaves, etc., and chew their food, while others have their mouth parts modified into beak-like processes by which they can suck the juice out of leaves, stalks, etc., of plants, and consequently they have to depend on liquid food. In the case of insects with biting mouth parts, stomach poisons are applied to the leaves which kill the insects when they are eaten with the leaves.

Lead Chromate is a very good stomach poison. It is a heavy yellow substance, does not injure the foliage when applied to plants and adheres extremely well in spite of rain and wind. It is not as poisonous as the arsenical compounds. It should be applied in the form of fine mist, so that there may be an even film of it on the foliage. On an attacked crop the strength should be 1 pound in 64 gallons of water. It also acts as a good deterrent to plant-feeding insects when the strength can be reduced to one pound in 100 gallons of water.

APPENDIX IV.

CRUDE OIL EMULSION.

Two types of mouth parts are to be found in the insect world,—biting and sucking. Insects with biting mouth parts chew their food, while the others have their mouth parts so modified as to form beak-like processes by which they can suck the juice out of leaves, stalks, etc., of plants, and consequently, they have to depend on liquid food. For the former stomach poisons are applied to the food which, acting upon their stomachs, kill them. For the latter, poison applied to the outside of leaf would be useless since they feed on the sap only. For these insects such poisons are used as will kill them when their bodies are wetted with them. These are known as contact poisons.

Kerosine oil is a very good contact poison, but if applied to plants in undiluted form it burns their leaves. Since it does not mix with water, it must be made into an emulsion with soap and water before use. In this form it does not injure the plants but its effect on insects remains just the same. A ready made emulsion obtainable in the market, is Crude Oil Emulsion, prepared at the Imperial Entomologist's suggestion. This has been found to be the best all-round contact poison. It should be applied in the form of a fine mist by means of a spraying machine against all soft bodied insects, such as, Green fly, Mealy bug, Green bug, Thrips, Leaf-hoppers, etc. One application kills a large number of them, and a second application completes the work. The strength should be one-third pint to one pint of the material in 4 gallons (one kerosine tinful) of water : (one-third pint—weak ; half pint—standard ; and one pint—strong).

APPENDIX V.

FUMIGATION.

Before storing seed or grain in godowns and also whenever the grain is found to be attacked by insects, it should be fumigated. The process is as follows :—

Place the seed or grain in an air-tight bin or earthen “jala” or “goli.” Measure out Carbon Bisulphide at the rate of one ounce per fifteen cubic feet of space in the storing vessel and pour it over a wad of cotton in a small open vessel placed on the grain. Close the lid immediately so that the gas may not escape ; the lid and other cracks on the sides should be completely plastered up with mud so as to make the vessel air-tight. After twenty-four hours, remove the lid and allow the gas to evaporate away. The contents of the vessel are then to be aired for a short time and stored again in air-tight bins or jars.

Fumigation does not make seed insect-proof ; it only kills the insects and eggs present in the seed at the time of fumigation, so that if the seed is not carefully stored after fumigation, it will have every chance of being attacked again. The storing vessel must be as air-tight as possible, so that the minute insects may not get into it again through cracks and attack the treated grains. If properly fumigated and carefully stored, seed will keep free from insects for any length of time. Fumigation, if properly carried out, does not affect the power of germination of seeds.

Carbon Bisulphide is extremely inflammable and explosive, so the following precautions must be taken when using it :—

- (1) It should be kept in a glass stoppered bottle in a safe place under lock and key.
- (2) No light, no pipes, cigarettes or any other kind of fire should be allowed near the place where fumigation is going on.
- (3) Never take a bottle of Carbon Bisulphide near a fire or lighted lamp.
- (4) Never keep a bottle of Carbon Bisulphide standing in the sun or in any place where it can get hot.
- (5) Fumigation should be done in a place to which no outsider can get access while the fumigation is proceeding.

APPENDIX VI.

LAMP TRAP.

A lamp trap consists of any kind of kerosine lamp (preferably a hurricane lantern) which gives a steady bright light and is not blown out by ordinary wind, placed in a big shallow basin filled with water with a small quantity of kerosine in it. Many insects are strongly attracted by light and advantage is taken of this for killing those insect pests, which fall under this category, in the field. When a lamp trap is set up in the field at night for a particular pest, the flying adults come to the light in numbers, flutter round the lamp for some time, and then drop in the kerosinised water in the basin below the lamp and die. The adults, if thus systematically trapped for some days, would not be able to lay eggs on the plants, and if the work be done in time, *i.e.*, when the adults are just coming, the prospective damage is avoided. It is to be noted that this method does not hold good for any and every insect, it is only for those which are attracted to light.

An Acetylene Lamp, "Meduse Lamp Trap," specially made for the purpose, can be obtained from the Planters' Stores Agency, Ltd., Calcutta, for Rs. 12-8.

APPENDIX VII.

PARASITES AND PARASITE BOXES.

Parasitism is a common phenomenon in insect biology. The plant-feeding insects are preyed upon by various other small insects which feed on them in the same way as they feed on plants. These insects pass a period of their lives inside their hosts' bodies and eventually kill them. In cases of parasitism, the following sequence of events generally occurs. Under favourable circumstances a parasitic insect deposits one or several eggs on the body of a host insect. The minute young insects burrow into the hosts' body as soon as they hatch. There they pass their larval stage feeding on the tissues of the host, until they are full fed and ready to pupate. They may pupate inside the body or come out of it to pupate outside. The host insect usually dies before the parasite pupates, but in many cases it succeeds in pupating. In course of time the adult parasites come out and lay eggs on other healthy hosts.

In order to take advantage of this natural check, parasite boxes have been introduced. It consists of any tight-fitting small box with a lid of wire netting. The parasitised insects are placed in it and fed regularly with their food-plants to keep them alive. The parasites go on feeding on their hosts' tissues and in due time come out as adult insects. The adult parasites, being much smaller than the hosts, make their way out through the netting and lay eggs on healthy hosts in the fields while the adult hosts, if any are still alive, cannot come out through the meshes. A parasitised insect can be recognised without much difficulty by the presence of minute grubs in it.

In the case of a pest whose activities are confined to some particular season during which a number of broods of increasing size are produced in rapid succession, it usually happens that the small earlier broods are almost entirely free from parasites, while in the larger later broods a very large proportion of the insects are parasitised. Every attempt should be made to assist the increase in number of the parasites by the use of parasite boxes during the early stages of the attack.

APPENDIX VIII.

TOBACCO DECOCTION.

Soak 2 lbs. of tobacco in 2 gallons of water for 24 hours, or boil for half an hour. Dissolve $\frac{1}{2}$ lb. of bar soap or 1 pint of soft soap in the mixture. This is the stock solution. For application dilute this stock solution with 7 parts of water. It can then be sprayed on the affected plants with a spraying machine or with a garden syringe if the former be not available.

APPENDIX IX.

BORDEAUX MIXTURE.

As an all-round fungicide or fungus destroyer no preparation is so satisfactory as Bordeaux mixture. It is easy of preparation and safe of application, besides being cheap and effective.

PREPARATION.—In a large earthen or wooden vessel containing 25 gallons of water 6 pounds of Copper Sulphate are dissolved by tying the Copper Sulphate in a gunny sack and suspending it just under water. In another earthen or wooden vessel 4 pounds of good quality quicklime are slaked with small quantities of water until a smooth paste free from grit or small lumps is obtained; this is made up to 25 gallons by adding more water to it. It is then allowed to cool. When the Copper Sulphate has completely dissolved and the milk of lime has become cool the latter is thoroughly stirred, and then the two liquids are slowly poured into a barrel capable of holding 50 gallons. The mixture is then given a final stirring. In order to be sure that the mixture is safe for use, it should be tested by dipping a pen-knife into it and seeing if any metallic copper is deposited on the blade. If copper is deposited on steel the mixture is not safe and more lime should be added and the liquid tested again. When no metallic copper is deposited on the blade the mixture is safe and ready for use.

USE.—The diseased plants or parts of plants may be washed or sprayed with the mixture with an ordinary syringe or a sprayer (*vide* Appendix II).

APPENDIX X.

STERILIZATION OF SEEDS BY HOT WATER

This method is also known as "Jensen's hot water method" and is useful in disinfecting seeds of wheat, oats, etc., from smut spores. It is used in the following manner :

Provide two large vessels, two small vessels, two thermometers ranging up to 150° F., a watch and a loosely woven gunny bag. Half fill the larger vessels with water and heat the same to about 120° F., in one and to 132° F. in another. In one of the smaller vessels there should be cold water and in the other boiling water. Loosely fill the gunny bag with the seeds to be sterilized and place it in the vessel containing water at 120° F. Shake it thoroughly so that every grain is wetted and heated. When this has been done take out the bag from the water, allow the water to drip and quickly plunge the bag in the second vessel containing water at 132° F., give it a good shaking and take the temperature ; if it has fallen below 132° F, add boiling water to bring it to 132° F. If the temperature is higher than 132° F., add cold water to bring it down to 132° F. In short, try to keep the temperature constant at 132° F., and shake the bag from time to time so that every grain is wetted and heated to 132° F. Continue this for ten minutes, then take out the bag and spread the seeds on a clean floor or cloth. Allow them to dry slightly and sow.

The following precautions should be taken in the above treatment (i) under no circumstances the temperature of the water in the second vessel should be allowed to go beyond 135° F., as it would not only kill the smut spores but also the seeds ; (ii) the volume of water in the second vessel must be at least six times more than that of the seeds treated at any one time ; (iii) care should be taken that every seed gets wetted ; lastly (iv), the seeds must not remain in the second vessel for more than 15 minutes.

APPENDIX XI.

STERILIZATION OF SEEDS BY COPPER SULPHATE AND BY FORMALIN.

1. Instead of sterilizing seeds by Jensen's hot water method they may be disinfected by means of a weak solution of Copper Sulphate. In this method one pound of Copper Sulphate is dissolved in about 20 gallons of water by suspending the Copper Sulphate crystals tied in a gunny sack over the water. The seeds to be sterilized should be plunged into the solution and stirred for a while; after which they should be allowed to remain in the solution for about 12 hours when they may be taken out, partially dried and sown.

2. Instead of Copper Sulphate a liquid which is commercially known as Formalin may be used in weak solution with advantage in sterilizing seed potato and various other seeds such as wheat, oats, etc. For this purpose one ounce of Formalin may be dissolved in 2 gallons of water. The seeds to be sterilized may be soaked in the solution for half an hour to one hour before sowing.

APPENDIX XII.

SULPHUR DUSTING.

In many cases where plants are affected by fungi which spread on the surface of leaves, etc., such as the mildews, dry sulphur is recommended to check the spread of the disease. In such cases finely powered sulphur or the "flowers of sulphur" are dusted on the leaves. For this purpose a small cylindrical tin box with finely perforated lid is useful from which the sulphur may be dredged on the leaves. In some instances better results are obtained by mixing powdered quicklime with the sulphur taking care always to have an excess of sulphur. The leaves should be damp or moistened with water when the sulphur is applied.

APPENDIX XIII.

ROSIN WASH.

“ Powder 3 pounds of rosin and add it to half a pound of Caustic Soda (98 per cent.) dissolved in half a gallon of water in a kerosine tin. Boil and add half a pint of fish oil when the rosin is dissolved. Continue boiling, slowly adding cold water, till the mixture amounts to 3 gallons. If the mixture is then a clear thin brown liquid, which mixes with water producing no milkiness, it is ready and may be removed from the fire. Dilute with 12 gallons of water to make wash ready for use. One pound of rosin is used for every 5 gallons of wash required. If Caustic Soda of 98 per cent. purity cannot be used, use a proportionate quantity of 70 per cent. ($\frac{3}{4}$ lb.) or lower grade caustic.” (Indian Insect Pests, p. 284.)

APPENDIX XIV.

HOW TO PACK AND SEND SPECIMENS

INSECTS.—In case of insect attacks, a good number of living specimens of the insects should be sent without any loss of time. They should be packed in a tin box, with perforated lid, to allow free access of air. The lid should not be soldered down. Inside the box, there should be a plentiful supply of the food-plant, packed very loosely (leaves when the insects have been found feeding on leaves, etc.), to keep them alive during the journey ; but the box should never be tightly filled up with these. If the insect lives in the ground it may be sent in slightly moist earth. Every care should be taken in packing that the insects may not be crushed or injured by any shaking of the contents of the package. Specimens of insects may also be sent preserved in spirit in small bottles.

FUNGUS.—Specimens should consist of the diseased parts of the plants dried between blotting papers, sufficient pressure being applied to prevent them from crumpling. In the case of plants dying or drying up without any apparent cause the entire plants with roots should be sent. All specimens should be (1) packed flat in thin blotting paper ; (2) wrapped over in packing paper ; (3) tied with twine or thread ; and (4) despatched without any loss of time.

N.B.—The specimens should be sent direct to the Economic Botanist to the Government of Behar & Orissa, Sabour, E. I. R. (Loop) on the very day of collection and as an unregistered postal parcel. The following form should also be filled up :—

INFORMATION REQUIRED.

1. Locality.
2. Vernacular name of pest.
3. Name of crop affected.
4. Appearance of diseased plant and site of injury.
5. Date of commencement of attack or of first notice of it.
6. Supposed cause of attack.
7. Amount of damage done per bigha (in annas).
8. Extent of area damaged (in bighas).
9. Previous occurrence in same or previous year.
10. Are remedies applied by cultivators ?
11. If so what are they.
12. Any fact known of the life-history of the insect, *e.g.*, where the eggs are laid, time of emergence of the perfect insect, etc.
13. Any other information available.

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LEAFLET.

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